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PLATE I

Postmortem specimen showing under surface of liver. Duodenum and stomach laid open, revealing cholecysto-enteric fistula. A small stone can be seen projecting through gallbladder fundus into duodenum. Distal to this point, there have been replaced, for photographic purposes, three stones which were ultimately found impacted in the lower ileum and causing death from obstruction.

ANNALS OF SURGERY

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INTESTINAL OBSTRUCTION FROM GALLSTONES*

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INTESTINAL OBSTRUCTION from gallstones carries one of the highest mortalities among the various causes of acute bowel obstruction. It is likely, at first, to be but partial while the intermittent and none too characteristic symptoms, all to frequently, cause fatal delay in treatment. By the time obstruction becomes complete the patient is, frequently, gravely ill, this being especially true if the obstruction occurs, as it usually does, high in the intestinal tract.

Bartholin,[2] in 1654, is credited with the first published report of a gallstone perforating into some portion of the intestine. Courvoisier,[5] in 1890, analyzed all the then reported cases, 131 in number, his paper being one of the first to focus attention on the problem. A more recent and more comprehensive contribution, made by von Wagner,[18] in 1914, presented an analysis of 334 cases which were found recorded in the available literature.

In reviewing this subject one is impressed by the fact that relatively little has been written regarding it during the past 20 years, the majority of the papers in this time consisting of isolated case reports. It is our purpose to present an analysis of ten personally treated patients and a review of 140 other reported cases, constituting the most significant records of the past two decades, in the hope that, from their collective study, salient points may be emphasized which may prove helpful in a better understanding of gallstone ileus.

Incidence.—The occurrence of gallstone obstruction is rare, the incidence given in various reports, in relation to other causes of intestinal obstruction, varying from 1 to 5 per cent. Vick,[17] in an analysis of 6,892 cases of intestinal obstruction seen in 21 London hospitals during the period 1925–1930, refers to gallstones as the etiologic factor in 47 instances, a percentage of 0.68. Dulin and Peterson[8] stated, in 1939, that in the University of Iowa Hospital they

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

had seen ten cases during the preceding ten-year period, accounting for 5.3 per cent of all the cases of intestinal obstruction during that period. A survey recently conducted under the auspices of the British Medical Association revealed gallstones as the cause of intestinal obstruction in less than 1 per cent of all obstruction cases reported from seven London hospitals. Martin,[12] from a questionnaire sent to a number of American surgeons, indicated that, among approximately one-half million operations, there were but 16 cases of intestinal obstruction due to stones, or one among each 30,000 operations.

During the past 15 pears the relative incidence in our own hospital has been 4 per cent. In personal communications from other institutions the incidence was given as 1 per cent or lower during the corresponding period of time. These percentages indicate that the incidence is so relatively low that the surgeon may expect to encounter but a few cases during a lifetime, yet Dickson[7] states that he had had four personal cases in seven years. The author has treated four patients during the past three years and ten in 25 years among 2,720 gallbladder patients admitted to his service (Table I).

TABLE I

INCIDENCE

Geisinger Memorial Hospital
Service of Dr. H. L. Foss

Patients with diseases of gallbladder and biliary ducts	2,720
Patients with intestinal obstruction due to gallstones	10
Incidence of gallstone obstruction among total gallbladder cases	0.3%

The relative ratio of cholelithiasis incidence in the female and male is generally given as five or six to one. It is natural to expect that the ratio should be essentially the same in gallstone ileus. In the collected series studied there were 130 females and 20 males, a ratio of 6.5 to one (Table II). In the study of 150 cases the average age was 62.8 years. The youngest and oldest patients were 31 and 83, respectively, with 55 being in the sixth decade and 41 in the seventh decade (Chart I).

TABLE II

SEX INCIDENCE

Female	130
Male	20
Total	150

Ratio of 6.5 to 1

Mechanism of Perforation.—Entrance of gallstones into the intestinal tract may occur in two possible ways: First, through the cystic and common ducts, and, secondly, by means of a fistulous opening between the gallbladder and some portion of the bowel. Probably all gallstones producing obstruction pass by the latter route, and some writers[19] go so far as to say that a gallstone large enough to cause obstruction is never capable of passing through the common duct and must necessarily reach the intestine *via* a cholecysto-enteric fistula. Murphy,[13] however, cites the incidence of a stone measuring 4.5x2.7

cm. transversing the common duct. Cabot[3] treated a patient in whom he found, at operation, several diverticula of the duodenum, and he speculated as to whether or not the fistula found between the gallbladder and duodenum had been formed in the base of a diverticulum.

The most common procedure is for the stone to perforate through the gallbladder fundus into the duodenum or upper ileum. However, fistulae are reported[14] as having been found connecting the gallbladder and the stomach, the jejunum, the ileum, the colon, and even the urinary bladder. A study of postmortem findings in 42 patients in this study of collected cases revealed the site of the fistula to be between the gallbladder and the duodenum in 41 (Fig. 1). In one case there was no fistula, but the cystic and common ducts were dilated sufficiently to have permitted the passage of the stone. Wakefield, Vickers, and Walters,[19] studying operating room and autopsy findings, found that, of 176 cholecysto-enteric fistulae observed at Rochester, the tract occurred between the gallbladder and duodenum in 101, between the gallbladder and colon in 33, and between the gallbladder and stomach in seven. This information, dealing with the site of the fistula, agrees generally with the findings of other authors. The fact that the gallbladder normally lies anterior to the first part of the duodenum and in the closest proximity to it, accounts for the fistulae forming between these two structures in the majority of instances.

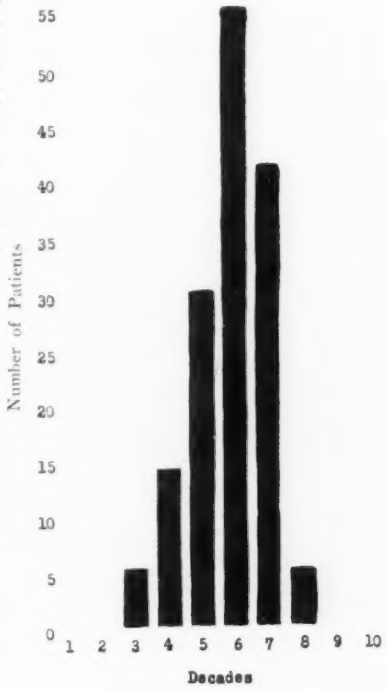

CHART 1.—Age incidence.

The process of perforation begins, naturally, with cholelithiasis followed by ulceration and erosion of the gallbladder wall and fistulous tract formation. Associated pericholecystitis first causes formation of adhesions between the gallbladder and some portion of the intestine, the perforation occurring within a mass of inflammatory tissue which probably accounts for the usual absence of an associated peritonitis. In many instances the gallbladder atrophies after it has emptied itself and has forced the stone into the bowel, as is evidenced by the usual findings of small contracted fibrous gallbladders and the fibrous remnants of a cholycysto-enteric fistula at the time of operation or postmortem examination.

Intestinal obstruction may occur without the gallstone actually entering into the lumen of the intestine. Wakefield, *et al.*,[19] cite two instances in which the gallbladder had perforated into the mesentery of the small intestine and

the subsequent tumefaction and abscess formation were sufficient to produce the clinical signs and symptoms of intestinal obstruction. In both cases uneventful recoveries followed operation.

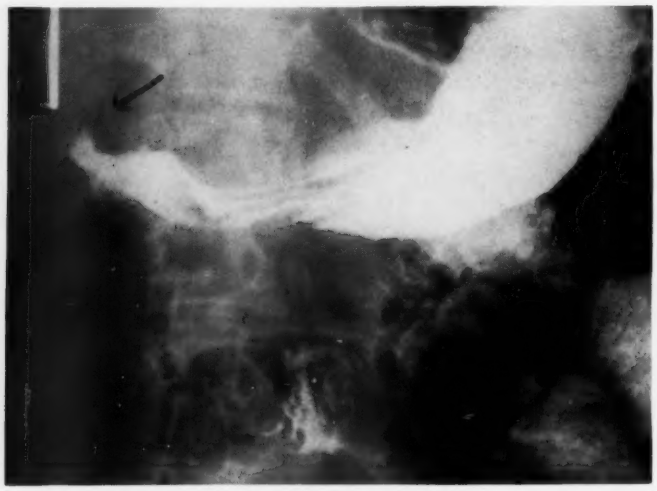

FIG. 1.—Roentgenogram of stomach and duodenum of patient with cholecysto-enteric fistula. Arrow points to projection of opaque medium through fistulous tract, uniting gallbladder and duodenum with gas bubble, immediately above, in gallbladder fundus.

SYMPTOMS AND DIAGNOSIS.—The symptoms of intestinal obstruction due to gallstones are less clear-cut than when obstruction results from other and commoner causes. Essentially, the clinical picture is that of ileus, but there are certain features of the symptom complex that may suggest the possibility of a gallstone being the causative factor.

In the majority of cases there is a long and usually intermittent history of gastric distress and epigastric pain. With a few patients there is a definite history of biliary colic. In ten (15 per cent) of the 150 cases analyzed there even had been jaundice. If a patient, particularly a female in the latter decades of life, has symptoms of intestinal obstruction with a past history suggesting gallstones, one should consider the possibility of gallstone obstruction. It is possible, of course, to have similar symptoms in intestinal obstruction from commoner causes, yet, in such instances there should be objective findings such as hernia, weight loss, anemia, and the other characteristic signs of malignancy of the intestinal tract. The latter type of obstruction is likely to be more gradual in its development due to the progressive narrowing of the lumen, whereas gallstone ileus, characteristically, presents intermittent symptoms followed by suddenly occurring complete obstruction. While the opaque enema is of value in ruling out an obstructing neoplasm of the colon, it is of little aid when the obstruction is due to a gallstone, as the majority of obstructions occur in the small intestine. A plain film, however is of the greatest assistance.

Associated gallbladder disease and the slow development of the obstruction may obscure the picture. To quote Dulin and Peterson[8]: "If there has been previously recognized disease of the gallbladder, the early symptoms of obstruction are easily misinterpreted since the pain, nausea and vomiting resulting from the obstruction are not unlike those of acute biliary colic."

Surprisingly, perforation may occur and not be accompanied by pain or discomfort. However, in the majority of instances there is experienced an acute episode of epigastric pain which the patient reports as being of a somewhat different character from that of previous attacks of gallstone colic which may have been experienced. It is also common to discover no past history that might suggest the presence of chronic cholecystitis or cholelithiasis. As shown in Table III, in this series 23, or 15.3 per cent of the 150 patients,

TABLE III

SIGNIFICANT DATA IN PAST HISTORY OF 150 PATIENTS

Collected Series

	Number of Patients	Percentage
Previously good health	23	15.3%
Pain compatible with gallbladder colic	70	46.6%
Pain compatible with perforation of gallbladder	48	32.0%
History of jaundice	15	10.0%

specifically affirmed that, previous to the onset of the obstruction, they enjoyed the best of health. It is in such cases that it is difficult to make a primary diagnosis. The diagnosis is often delayed because of an indefinite history of intermittent partial obstructive symptoms unassociated with any evidence suggesting gallstone disease. In such cases one might be doubtful as to whether or not the obstructing stone was actually a gallstone or an intestinal enterolith. In the present study, 48 patients, or 32 per cent, gave a definite past history of epigastric pain which, in contrast to previous episodes of biliary colic or epigastric pain and discomfort, could be interpreted as being associated with the process of perforation.

Intestinal Obstruction.—After a gallstone perforates the intestine it may pass spontaneously without causing symptoms or there may be intermittent obstructive symptoms which, after a variable time, disappear as the stone is expelled per rectum or, finally, the stone may fail to leave the small bowel and ultimately completely block it. An important factor is the size of the stone. Hennessy[11] states that if the calculus is less than two or three cm. in dimension, the chances are that it will pass spontaneously. Of von Wagner's[18] 334 accumulated cases, in 93 the stones passed spontaneously. Usually, when the stone reaches the rectum the patient becomes aware of a sense of pressure and has tenesmus and a constant urge to defecate. Occasionally mechanical removal of the stone under an anesthetic becomes necessary.

The usual happening, with a large gallstone, one 25 Mm. in diameter or larger, is for it to become wedged in the intestinal tract and cause intermittent partial or complete obstruction. The size of the calculus at the time of the perforation may be of such proportions as to preclude spontaneous passage,

or it may act as a nucleus for the deposition of fecal concretions so that it becomes impossible for peristaltic action to move it further. As the stone becomes arrested in its course the bowel is thrown into a violent spasm and there occur severe colicky attacks associated with nausea and vomiting. As the spasm relaxes the symptoms subside only to recur after variable periods of time as the stone becomes impacted farther along the intestinal tract. If the calculus once passes into the cecum its course is usually uninterrupted unless it is temporarily arrested in the rectum. In the present collected series the location of the obstruction, in 125 of the patients, was in the ileum, and, of this number, 88, or 70.4 per cent, were in the terminal portion, within 12 inches of the ileocecal valve (Table IV).

TABLE IV

LOCATION OF OBSTRUCTING GALLSTONE

Collected Series

Duodenum	6	
Jejunum	14	
Proximal ileum	6	+ 125 in ileum
Middle ileum	31	
Terminal ileum*	88	
Colon	3	
Rectum	2	
Total	150	

* Eighty-eight, or 70 per cent, were in the *terminal* ileum.

The higher the point of obstruction the more severe the symptoms. It is only in the late stages that vomiting becomes fecal, which, as Handley[10] has aptly said, "Is not a sign of intestinal obstruction, but rather a herald of approaching death." If the stone is lodged in the duodenum or upper portion of the ileum, abdominal distention is not a prominent feature and visible peristaltic waves and intestinal patterns are rarely present. The fact that gas and feces distal to the site of obstruction may pass spontaneously, or with the aid of an enema, frequently is a factor in the delay in making an early diagnosis. Very rarely is a mass palpable, and in 31 cases in which roentgenologic studies were carried out, in only five, or 16.1 per cent, was a mass demonstrable. Tenderness with rigidity of the abdominal muscles is of little aid, for it is infrequent unless perforation occurs. The leukocyte count and the temperature are generally normal or only moderately elevated. If the obstruction is high and complete, shock and collapse rapidly occur, the outcome becoming fatal unless the condition is promptly recognized and relieved.

Roentgenologic Diagnosis.—In a recent and significant contribution by Rigler, Bowman and Noble,[15] the opinion is expressed that by properly conducted roentgenologic examinations "the almost total failure of specific diagnosis in gallstone obstruction with the corresponding high mortality can be corrected to a reasonable high percentage of accurate diagnoses, with an inevitable improvement in the recovery rate." They report the largest series yet presented of cases correctly diagnosed, preoperatively, by roentgenologic studies. The roentgenographic evidence (Fig. 1) on which they depend is:

(1) Air or contrast medium in the biliary system; (2) direct visualization of the stone; and (3) the roentgenologic evidence of intestinal obstruction.

In recapitulation, the symptoms of intestinal obstruction from gallstones are those of mechanical ileus. There may or may not be a past history of gallbladder disease. The early symptoms of obstruction may simulate biliary colic, but if there has been a previous history of cholelithiasis the patient will usually describe the present episode of pain as being of much different character. At first the obstruction is but partial, but may be absolute, and there is usually characteristic and frequent remissions of symptoms. Abdominal distention, tenderness and rigidity are frequently absent.

In the differential diagnosis one must consider such conditions as: (1) Intestinal obstruction due to adhesions, to hernia, to intussusception, or to volvulus; (2) perforated peptic ulcer; (3) mesenteric thrombosis; (4) acute pancreatitis; (5) acute appendicitis; (6) biliary colic; (7) renal colic; and (8) abdominal metastatic infarction. A good maxim to follow is that stated by Gilman[9]: "In absence of an incarcerated or strangulated hernia in elderly persons, in whom previous abdominal surgery has not been performed, one must consider gallstones as well as malignancy as the cause of obstruction."

Obstruction from Multiple Stones.—Multiple gallstones are not infrequently encountered in acute bowel obstruction but as a rule only one causes the obstructive symptoms (Plate I). When the obstructing stone is removed and is found to be faceted it indicates that there is, or has been, another gallstone which may still be in the gallbladder or is now in the intestine. A careful and systematic search should always be made when a faceted stone is discovered, and if others are found they should also be removed. One of our own cases, and several found in the literature, illustrate the importance of not overlooking a possible *second* stone at the time of the operation (Table V).

TABLE V

MULTIPLE STONES DISCOVERED AT OPERATION

Collected Series

Site of Obstructing Stone	Site of Second Stone
1. Terminal ileum	Transverse colon
2. Terminal ileum	Transverse colon
3. Terminal ileum	Sigmoid
4. Terminal ileum	Ileocecal valve
5. Terminal ileum	Just proximal to obstructing stone
6. Duodenum	Twelve inches below obstructing stone
7. Middle of ileum	In mass of adhesions beneath liver
8. Jejunum	Cecum
9. Middle of ileum	Just proximal to obstructing stone
10. Terminal ileum	Stone in process of perforating from gallbladder into duodenum

As in our case, postoperative abdominal pain and distention, of a susbequent obstruction, may be misinterpreted and delay in making the diagnosis result in the patient's death. Therefore, if an obstructing stone is faceted the surgeon should make a thorough investigation of the entire ileum especially that segment proximal to the site of the main obstructing stone (Plate I).

Operation.—The operation, as a rule, presents but little difficulty. Either a lower midline or a paramedian incision will give good exposure. Spinal is preferred to inhalation anesthesia, which is considered more dangerous since the patients are elderly and often are regurgitating intestinal contents. The obstructing stone is discovered by a systematic palpation of the entire small intestine. The point of obstruction is located either by following down the distended proximal bowel or by following up the lower collapsed portion of the intestine to the site of the obstructing stone. The loop of intestine containing the calculus is withdrawn from the abdomen and packs carefully placed around it so as to isolate it from the abdominal cavity. After applying an intestinal clamp on either side of the stone a longitudinal incision is made along the antimesenteric portion of the intestinal wall over the stone, which is then delivered. Although, in theory, it would be better to remove the stone through an opening made in an adjacent normal intestinal wall, it is the consensus of opinion that it is unwise to attempt to manipulate the stone from the site of its impaction. Most writers favor closing the incision transversely by a double Lambert suture reinforced with interrupted silk rather than longitudinally, since this technic is thought to offer less chance of a subsequent narrowing of the lumen.

Since sulfanilamide crystals have proven efficacious in abdominal surgery, especially where there is actual or potential soiling of the peritoneum, it would be wise to use it locally over the ileotomy site and in the subcutaneous tissues. We have recently used this chemotherapy procedure in various types of intestinal surgery and have been gratified with the results.

Mortality.—As patients suffering from an obstructing gallstone are usually elderly, and there is, customarily, a prolonged delay in admitting them to the hospital, it is not surprising that the operative mortality is high. In our group of ten patients the mortality was 50 per cent. The average duration of symptoms in the total mortality-group, prior to operation, was 6.2 days. Balch[1] has shown that but one of eight patients operated upon after the third day of obstruction survives, and reports that, of nine patients operated upon during the first three days, four will die.

The average duration of complete obstruction before the patients were admitted to the hospital, in our group of our five patients who succumbed, was 5.2 days. Delay in sending the patients to the hospital was the chief reason for the loss of these patients. Delay is the major factor in producing the high mortality level, and it is only by earlier recognition of the significance of the usually bizarre symptoms of this rare emergency, with earlier diagnosis and more prompt surgical intervention, that we can hope to lower it.

INTESTINAL OBSTRUCTION FROM GALLSTONES

Authors' Series of Ten Cases

Case 1.—Hosp. No. 5809: M. B., female, age 47. C.C.: "Gallstones."

History of dull pain in upper abdomen associated with nausea and vomiting at various times during past several years. Two days before admission, onset of dull pain in epigastrium which increased in intensity; nausea and vomiting with distention. Physical

examination revealed epigastric tenderness and rigidity. T. 95; P. 60; R. 18. Blood count: Hemoglobin, 92 per cent, R.B.C. 7,270,000; W.B.C. 21,600. *Preoperative Diagnosis:* Intestinal obstruction of undetermined origin. A gallstone 5 cm. in diameter was found obstructing the lower third of the ileum.

Operation.—Ileotomy with removal of stone. Gallbladder palpated and found to be small and fibrous, with many surrounding adhesions. Patient failed to respond and died six hours afterwards. Postmortem examination revealed a fistulous opening between the gallbladder and duodenum. The small intestine was distended but there was no evidence of peritonitis. The ileotomy suture line was intact.

Case 2.—Hosp. No. 11853: J. S. H., female, age 59. C.C.: "Vomiting."

Had experienced "gas in stomach" for 18 years. At irregular intervals had experienced attacks of acute epigastric pain associated with nausea and vomiting. Three days before admission had acute abdominal pain with vomiting. Enemata ineffectual. Physical examination: T. 99; P. 96; R. 24. No jaundice. Abdomen essentially negative. *Preoperative Diagnosis:* Intestinal obstruction; cause not determined.

Operation.—A large impacted gallstone was found obstructing the lower ileum. Ileotomy with removal of stone. Gallbladder palpated and found to be atrophied and fibrous. Uneventful convalescence with discharge on the fifteenth postoperative day.

Readmitted 11 years later. Chief complaint: "Soreness across the abdomen." Had been perfectly well following previous operation until two months ago, when patient began to have irregular episodes of epigastric soreness, which gradually disappeared. Was also troubled with "indigestion" and eructations of gas. No nausea, vomiting or jaundice. Physical examination revealed a well-developed and well-nourished woman of 60, not actually ill. No jaundice. There was generalized moderate tenderness over the epigastrium without rigidity. No abdominal masses palpable. *Preoperative Diagnosis:* Chronic cholecystitis.

Operation.—Small, fibrous, atrophic gallbladder containing no bile but having in its fundus one small stone about 0.5 cm. in diameter. Stone had nearly perforated the gallbladder into the duodenum, to which the gallbladder was firmly attached. Gallbladder isolated from duodenum and common duct, which was not enlarged, and removed. Discharged on the fourteenth postoperative day.

Case 3.—Hosp. No. 39660: J. B., female, age 66. C.C.: "Pain in the abdomen."

History of gallbladder colics for 15 years, none for past six months. No jaundice. Unregulated diabetes mellitus for ten years. Present trouble began three days before with onset of right lower abdominal pain. Nausea and vomiting, associated with constipation, not relieved by cathartics and enemata. Physical examination: T. 100; P. 100; R. 20. Abdomen moderately distended. No pain or tenderness. No masses palpable. Blood count: Hemoglobin 74 per cent, R.B.C. 5,430,000; W.B.C. 10,150, with an essentially normal differential count. Urine: 2+ sugar, with no acetone or diacetic acid. An abdominal plain film revealed almost complete obstruction in the lower ileum. *Preoperative Diagnosis:* Intestinal obstruction; cause undetermined.

Operation.—Large gallstone, 5 cm. long, faceted at one end, found wedged in middle portion of ileum. Removed. Ileum closed with chromic catgut, reinforced with interrupted silk. Gallbladder also contained one large stone. In spite of supportive measures and regulation of the diabetes the patient became irrational the following day and expired. (No autopsy)

Case 4.—Hosp. No. 43879: M. C., female, age 67. C.C.: "Constipation."

Prior to present illness patient had enjoyed good health. One week before admission experienced an attack of severe epigastric pain associated with nausea and vomiting. No bowel movement since onset of illness. Enemata were ineffectual. Rapidly increasing weakness with abdominal distention. Physical examination: T. 97; P. 100; R. 28. Patient acutely ill; no jaundice. Abdomen markedly distended. No masses palpable. No tenderness or muscular rigidity. Peristalsis audible and moderately active. Roentgeno-

gram of abdomen showed the large intestine to be widely distended with gas which stopped abruptly in the lower sigmoid. *Preoperative Diagnosis:* Intestinal obstruction.

Operation.—Spinal anesthesia: There was no evidence of organic lesion of the large bowel, but there was a large calculus, 4.5x2.5 cm., obstructing the ileum in its mid-portion. Ileotomy performed and stone removed. Postoperatively, there was a rapid rise in temperature, and the patient expired on the third postoperative day. (No autopsy)

Case 5.—Hosp. No. 44049: H. T. C., male, age 63. C.C.: "Vomiting and constipation."

Past history revealed that five years previously patient had had an attack of severe abdominal pain associated with vomiting and diarrhea. Since then has had "indigestion," but no severe pain until present illness. Three days before admission, while eating dinner, developed severe abdominal pain which was relieved partially by vomiting. The pain and vomiting continued, finally requiring a hypodermic. Physical examination: T. 98; P. 100; R. 28. Patient obese and acutely ill. No abdominal tenderness, but abdomen tympanitic and markedly distended. No masses palpable. Rectal examination revealed external hemorrhoids and a moderately enlarged prostate. Blood count: Hemoglobin 90 per cent, R.B.C. 5,590,000; W.B.C. 12,850, with a differential count of 90 neutrophils and ten small lymphocytes. *Preoperative Diagnosis:* Intestinal obstruction from gallstones?

Operation.—Distended loops of small intestine were found proximal to a calculus, 6x3 cm., which was obstructing the lower ileum. Ileotomy with the removal of the stone. There was slight spilling of intestinal contents. In spite of general supportive treatment, which included two transfusions, patient gradually became weaker and expired on the fourth postoperative day. The blood N.P.N., the day before death, was 120 mg. (No autopsy)

Case 6.—Hosp. No. 51299: H. T. C., male, age 63. C.C.: "Stone in rectum."

Eight days previously patient noticed something hard and obstructing in the rectum. Family physician had tried unsuccessfully to remove it manually. Cathartics produced free movements but mass remained. Past history revealed that for eight years patient had had attacks of acute epigastric pain, often requiring morphia. Physical examination: The abdomen was negative except for some tenderness in the left lower quadrant. Satisfactory rectal examination was prohibitive on account of tenderness from previous manipulation. Roentgenogram showed no evidence of a mass in the rectum. Cholecystogram revealed a nonfunctioning gallbladder. The day after admission, while straining at stool, a hard mass was seen and felt at the anal orifice. Upon manipulation, a cholesterin stone, 6 cm. in diameter, was removed. Patient promptly recovered.

Case 7.—Hosp. No. 74309B: C. G., female, age 71. C.C.: "Vomiting and constipation."

Upon admission, nine months previously, a diagnosis of acute cholecystitis and cholelithiasis had been made. First attack of epigastric pain occurred three months prior to that time. For a year, patient had been somewhat constipated, requiring a frequent laxative. Two days before final admission experienced severe pain across the upper abdomen associated with nausea and vomiting. There had been no bowel movement for five days. Nausea and vomiting continued. Repeated enemata were unsuccessful. Vomitus fecal. Physical examination: On admission, patient did not appear acutely ill. T. 96; P. 104; R. 20. Obese. Abdomen not distended, soft, with tenderness in lower quadrant upon deep palpation. A mass was palpable in the left lower quadrant just above the iliac crest, during the initial examination, but never afterwards. Hemoglobin 97 per cent, R.B.C. 5,160,000; Color Index 0.9+; W.B.C. 13,400, with a normal differential. Abdominal plain film showed evidence of partial intestinal obstruction. *Preoperative Diagnosis:* Intestinal obstruction from gallstones?

Operation.—Spinal anesthesia: Upon opening the abdomen, distended coils of the ileum were encountered, which were found to lead to a point of obstruction in the

upper third of the ileum, below which the intestine was collapsed. A calculus, 3.5x3 cm., was found to be the cause of the obstruction, which was removed by enterotomy, with closure of the bowel with running chromic catgut, reinforced with interrupted silk sutures. Upon palpating the gallbladder, a hard nodular mass was found inextricably associated with the first portion of the duodenum. There was also extensive diverticulitis of the sigmoid. Patient developed postoperative bronchopneumonia, which prolonged an otherwise uneventful convalescence.

Case 8.—Hosp. No. 81471: A. L., female, age 71. C.C.: "Pain in the left side." Had been told she had gallbladder disease and had had periodic "biliary drainage" for several years. Past history of several gallbladder attacks. For two weeks before admission patient had been below par. Three days previously she had experienced nausea and vomiting but no pain until day of admission, when pain became acute and located in left lower abdomen. Day before admission there had been two bowel movements. Physical examination revealed an elderly woman who appeared acutely ill and in great distress. T. 98; P. 92; R. 28. Urine: 3+ sugar; 1+ diacetic acid and 3+ acetone. There was moderate abdominal distention with marked tenderness in left lower abdomen. Hemoglobin 84 per cent, R.B.C. 4,760,000; W.B.C. 14,800. Abdominal plain film showed no definite evidence of intestinal obstruction. Continued to have intermittent, abdominal, colicky pains but no definite evidences of obstruction were present. *Provisional Diagnosis:* Partial intestinal obstruction from neoplasm or adhesions.

Operation.—On the fifth day an exploratory celiotomy was carried out under spinal anesthesia. Intestines not distended. Sigmoid explored but nothing found. While the hand was being passed across the upper abdomen a large stone was palpated in the upper ileum. Ileotomy, a faceted stone, 3.5x2 cm., being removed. No other stones were palpable. Postoperative course was uneventful.

Case 9.—Hosp. No. 82666: I. R., female, age 70. C.C.: "Vomiting, pain, and constipation."

In good health until onset of anorexia and weight loss seven months previously. Increasing constipation for past four to five months, requiring daily cathartics. No blood or mucus in stools. Four days before admission onset of severe pain across midabdomen, with nausea and vomiting. Cathartics and enemata ineffectual. Physical examination showed an elderly woman, dehydrated and acutely ill. T. 96; P. 100; R. 16; Hemoglobin 104 per cent, R.B.C., 5,590,000; W.B.C. 14,500. Abdomen tympanitic, with generalized tenderness and slight rigidity. No masses palpable. Abdominal roentgenogram on day of admission showed no evidence of intestinal obstruction. Intravenous fluids and supportive treatment instituted. *Preoperative Diagnosis:* Intestinal obstruction of unknown etiology.

Operation.—Exploratory celiotomy was performed, under spinal anesthesia: Upon opening the abdomen the upper ileum was found to be distended, the remainder of the bowel being collapsed. By following down the distended portion a large, faceted gallstone, 3.7x3x2.5 cm., was found completely blocking the ileum and tightly wedged within it. The stone was readily removed by making a small longitudinal incision in the ileum, which was closed with two running sutures of chromic catgut reinforced with interrupted sutures of silk. Wound closed in usual manner with steel wire reinforcements in the fascia. Two transfusions of 500 cc. of citrated blood administered postoperatively. On the fifth postoperative day patient developed abdominal pain and distress. Moderate distention relieved partially by nasal decompression. The temperature became septic, the patient rapidly becoming worse, and expiring on the eighth postoperative day.

Postmortem examination revealed: (1) generalized peritonitis; (2) a well-healed fistula between gallbladder and the first portion of the duodenum; (3) ruptured ileotomy sutures, with a second impacted gallstone proximally; (4) pneumonia, right lower lobe; and (5) chronic nephritis.

Case 10.—Hosp. No. 88821: M. M., male, age 60. C.C.: "Vomiting of five weeks' duration."

For the previous year patient had experienced distress after meals. Five weeks before admission he began to vomit several hours after eating, which was associated with much belching of gas. The vomiting became more severe, until the patient was unable to retain even fluids. There had been a weight loss of 20 pounds. At no time had there been melena, jaundice or clay-colored stools, or any suggestion of pain in the epigastrium. It was obvious that the patient was suffering from high intestinal obstruction. The roentgenologic report revealed: "There is a high-grade obstruction near the pylorus. Peristalsis does not proceed all the way to the pylorus but stops a few centimeters proximal thereto. There is a large retention at six hours. *Roentgenologic Diagnosis:* Pyloric obstruction, probably due to carcinoma." *Provisional Preoperative Diagnosis:* Pyloric obstruction from carcinoma or possibly from cicatrizing ulcer.

Operation.—Spinal anesthesia: "No evidence of carcinoma. Duodenum densely adherent to a small atrophic gallbladder, containing no bile, but four round, faceted stones, each about 2 cm. in diameter, which were attempting to perforate into the first portion of the duodenum. The duodenum was separated from the gallbladder with great difficulty because of dense adhesions. About two-thirds of the gallbladder was resected, the gallstones being previously removed." Convalescence followed normally, and the patient was discharged on the fifteenth postoperative day.

SUMMARY

The literature of gallstone ileus during the past two decades has been reviewed, and 140 reported and illustrative cases are analyzed together with ten cases personally treated by the authors. While an exhaustive study of the literature covering the past 20 years was made, it is not contended that 140 represents the total number of cases reported, but, undoubtedly, it includes the majority of them.

The relative incidence of intestinal obstruction from gallstones varies from 1 to 5 per cent. In the series of 150 studied, there were 130 females and 20 males, a ratio of 6.5 to one, which closely corresponds to the relative incidence of cholelithiasis in the two sexes. The majority of patients were in the sixth and seventh decades of life.

A gallstone large enough to cause intestinal obstruction very rarely passes *via* the common duct, the most common route being *via* a fistula between the fundus of the gallbladder and some portion of the duodenum. The sequence of events begins with cholelithiasis, followed by ulceration and erosion of the gallbladder wall, pericholecystitis, and fistulous tract formation.

In the collected series of 150 patients 23, or 15.3 per cent, presented no history suggestive of gallbladder disease, and 48 patients, or 32 per cent, gave a history of epigastric pain which could be interpreted as being associated with the process of perforation. After the stone enters the small intestine it may pass spontaneously, but more often it produces characteristically intermittent obstructive symptoms. The most frequent site for the stone to become lodged is in the terminal portion of the ileum.

Features of the symptom-complex are emphasized in the hope that the entity may be more easily recognized, for it is only by early surgical intervention that the high mortality rate can be lowered. The finding at operation of a faceted stone is emphasized as being indicative of possible multiple stones, the

presence of which should always be ruled out. An abstract of the authors' ten personally treated cases is presented.

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DISCUSSION.—DR. E. VERNON MASTIN (St. Louis, Mo.): I have operated upon five of these cases; in four of them the stone was in the ileum and in one it was in the rectosigmoid. I feel that the high mortality rate can be reduced considerably by simply delivering the dilated obstructed loop of ileum that contains the gallstone, outside of the abdomen as a loop-ileostomy, close the abdomen around the ileum, protect the wound adequately with vaselined gauze and, some hours later, incise the intestine and remove the stone. In this way, we will obviate the risk of peritonitis from leakage of the suture line, which is so prone to occur when a primary suture is employed, if the ileum is markedly distended. There have been no deaths in the three cases in which this procedure was followed, while one, in which I removed the stone and sutured the ileum, died of peritonitis due to leakage.

I have a case to report in which the obstruction was due to a gallstone (Figs. 1 and 2) that was lodged in an old diverticulum of the rectosigmoid. This woman had had severe gallstone colic for years but had refused surgery.

She entered the hospital, in 1931, as an emergency, with generalized peritonitis, the result of a ruptured diverticulum of the rectosigmoid, from which she recovered completely. In 1932 I repaired a large postoperative ventral hernia and at that time exploration of her gallbladder revealed a large stone about 4 cm. in diameter. She was admitted again in 1939, with a history of a very severe attack of gallstone colic which began one week previously. She was recovering from this attack when she developed symptoms of in-

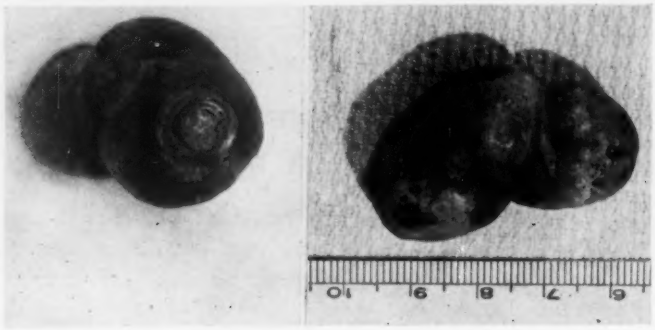

FIG. 1. FIG. 2.

FIGS. 1 and 2.—Photographs of the gallstone that was removed from the rectum, at the time of operation.

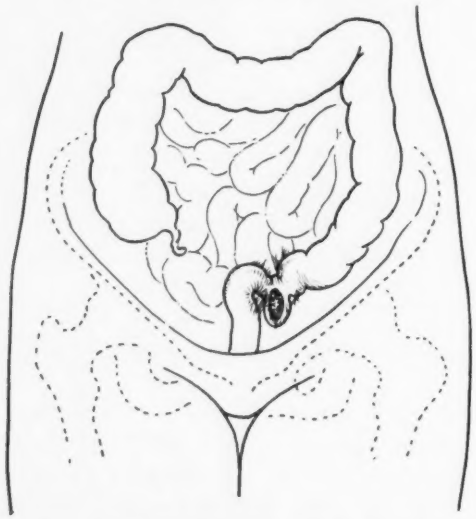

FIG. 3.—Diagrammatic representation of the anatomic relation of the rectosigmoidal diverticulum, containing the indwelling gallstone.

testinal obstruction, and exploration revealed a large gallstone impacted in a strictured area of the rectosigmoid (Fig. 3). By considerable dissection and manipulation it was possible to free the rectosigmoid and pass the stone through the somewhat strictured portion of the bowel into the rectum, whence it was easily removed by an assistant, with his finger passed through the anus. Exploration of the gallbladder region at this time showed only a mass of dense adhesions between the hepatic flexure of the colon and the under surface of the liver.

Two weeks later a gastro-intestinal series and barium enema failed to show any fistulous communication between the intestine and the gallbladder, and the gallbladder was not visualized by cholecystography (Fig. 4). Apparently the cholecystocolic fistula had healed prior to the time the barium enema was given. When last seen a few weeks ago, she stated she had not had any more attacks of gallstone colic.

DR. GEORGE G. FINNEY (Baltimore, Md.): I was interested in Doctor Foss' case because in the last few years, on the ward service of the Women's Hospital, in Baltimore, we have had three cases of obstruction due to gallstones. One of these was of particular interest, because this woman came into the hospital with symptoms of an acute attack five days before. Because of having had two other cases previously, a plain film was taken of the abdomen, and there was a suspicious shadow in the ileum. Both the common duct and the hepatic duct were definitely outlined with air, and, therefore, diagnosis was made of the intestinal obstruction due to gallstone.

FIG. 4.—Roentgenogram following a barium enema, 14 days after the gallstone had been removed through the rectum, showing the irregularity of the diverticulum of the sigmoid flexure, in which the gallstone was lodged, and also the hepatic flexure of the colon closely adherent to the undersurface of the liver.

She was operated upon and the gallstone was removed. It was located about two feet below Treitz's ligament. She did well for two days and then began to vomit and showed further signs of obstruction. Roentgenograms were again taken, and, sure enough, there was evidence of a second gallstone at a lower level in the ileum. She was operated upon again, and the second stone was removed. That patient lived.

Of the three cases we have had, one has died. This is a relatively high mortality, as indicated by Doctor Foss also.

DR. HAROLD L. FOSS (Danville, Pa., closing): I can add but little to what has been said, but I was greatly interested in Doctor Mastin's patient who had an obstructing gallstone in a diverticulum. Surely that is a rare condition. Doctor Mastin's suggestion of exteriorization of the loop of ileum containing the obstructing stone may be an answer to the question of how we may decrease the distressingly high mortality of this emergency. The fact that Doctor Mastin's three patients, upon whom he operated by the exteriorization technic, lived, while one upon whom he carried out the usual procedure died, is, of course, a testimony in favor of his suggestion. The stone must be removed, whatever the technic is to be, and the bowel must be firmly closed so there cannot be the slightest possibility of leakage. A nonabsorbable suture in the outer coats is most essential, I believe, in this step, and here we have found cotton a particularly satisfactory suture material.

THE SURGICAL ASPECT OF CONGENITAL ABSENCE OF THE GALLBLADDER*

REPORT OF TWO CASES

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RARE CONDITIONS do not always attract the general interest of the medical profession as do the more common ones. There are some conditions which are thought of as rarities only because few cases have been reported. And yet we know that although many surgeons come upon very remarkable and rare cases, the information concerning these cases never gets beyond their office files. When an anomaly, hitherto considered extremely rare, is encountered almost simultaneously by two surgeons working separately in the same city, one begins to doubt if that anomaly is so rare after all. The purpose of this paper is to bring to the attention of surgeons two cases of congenital absence of the gallbladder in adults, and to consider certain practical surgical aspects of the anomaly.

There have been many theories of the causation of congenital absence of the gallbladder. Mauro,[1] in a recent paper, offers what we feel to be a reasonable explanation. As early as the second week of fetal life the hepatic diverticulum develops a ventrocaudal extension, the cavity of which is soon obliterated by proliferation of the epithelium. The extension from which the gallbladder develops is located in the mesenchymatous tissue and remains connected with the hepatic diverticulum by a pedicle from which the cystic duct later develops. The hepatic duct originates from the cranial portion of the hepatic diverticulum and the common bile duct from the caudal portion. During the third fetal week, the liver becomes more separated from the intestine and the bile ducts are thus lengthened and at the same time occluded. The common bile duct reopens during the fourth week and the hepatic duct during the fifth week. Sometime during the sixth week of fetal life, the cavity of the gallbladder reappears. It is almost impossible to determine at the operating table whether absence of a certain portion of the biliary system is due to agenesia or to atresia. This fact is especially true of the gallbladder, which represents the terminal extension and, therefore, may never have existed, or may have undergone secondary involution; on the other hand, if the terminal portion is present, the absence of an intermediate portion can be due only to atresia.

It has been generally accepted that congenital anomalies are apt to be multiple. There are numerous reports of congenital absence of the gallbladder in infants associated with atresia of the bile ducts, according to Bruchsaler[2] and Ladd;[3] this paper is not concerned with such cases. Since

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there is a possibility that one of our cases (A. O. L.) represents an intrahepatic situation of the gallbladder, we must not neglect that condition. Kehr, quoted by Walter,[4] reported three such cases, in all of which he resorted to exploratory incision of the liver and found the gallbladder, which contained calculi. In one of his cases, there was profuse hemorrhage which required packing; the patient died on the twelfth postoperative day of diffuse cholangitis and peritonitis. At operation, however, one cannot discover the presence of an intrahepatic gallbladder by any less formidable procedure, since aspiration is done blindly and the bile obtained might well come from one of the bile ducts. Mauro[1] warns against all attempts to perform cholecystectomy in such cases because of the danger of uncontrollable hemorrhage. It is interesting to note that the great majority of intrahepatic gallbladders reported have contained one or more calculi.

Gross[5] records from the literature 38 cases of congenital absence of the gallbladder, in which there was no other anomaly of the liver or biliary system. He does not include two cases observed by Whipple,[6] quoted by Sarma,[7] or the report by Danzis[8] of one case. Since the appearance of Gross's paper, five other cases have been reported (Mauro,[1] Sarma,[7] Melville,[9] Robertson[10]), bringing the total to 46.

Case reports of the anomaly have been notably lacking in the essential data. A review of the 11 complete cases reported, including our own, shows that calculi were found in the common bile duct in all, and that the duct was dilated in ten and within the limits of normal in only one. These facts agree with the finding of a proportionately large common bile duct in animals possessing no gallbladder, and also with the common observation that the biliary ducts undergo dilatation following cholecystectomy. The gallbladder fossa may be absent and the quadrate lobe indistinct in outline. Corresponding with the greater incidence of cholelithiasis in females, we find that congenital absence of the gallbladder is twice as common in women as in men. Symptoms usually take the form of a gaseous type of indigestion, with intolerance of fatty foods, and sometimes episodes of sharp lancinating pain in the right upper quadrant referred through the chest to the inferior angle of the right scapula, and occasional jaundice. Thus far, to the best of our knowledge, the diagnosis has never been made preoperatively.

The first case to be presented is that of the senior author (G. G. F.):

Case A. O. L.—A male, age 68, referred by Dr. Louis P. Hamburger, was admitted to the Union Memorial Hospital, March 26, 1941, with the complaint of recurrent attacks of upper right quadrant pain, together with fever, nausea, vomiting, and jaundice of a little more than a year's duration.

Past History.—This contains a number of interesting and important facts. At age 17 the patient had a rather severe case of typhoid fever, and at age 32 he had an attack of what was called pleurisy. At age 50 the patient had a siege of dysentery, with blood and mucus in the stools. For the 23-year period from 1910 through 1933, he had suffered with frequent prolonged attacks of hyperacidity, regurgitation, and

sharp epigastric pain, coming on three to four hours after meals. The pain would frequently awaken him at night. During this period he was put on a restricted diet on numerous occasions, and was hospitalized for treatment three separate times. The last occasion was in December, 1933, at which time he spent some three weeks in the Union Memorial Hospital under strict dietary care, with the diagnosis of duodenal ulcer. From this time, the patient had been completely relieved of all symptoms referable to his gastro-intestinal tract until the beginning of his present illness.

Present Illness.—In January, 1940, the patient first had an attack of severe right upper quadrant pain which radiated through to the back. This was associated with nausea and vomiting and a moderate degree of fever. The pain was so severe that a hypodermic was required before relief could be obtained. The following day clay-

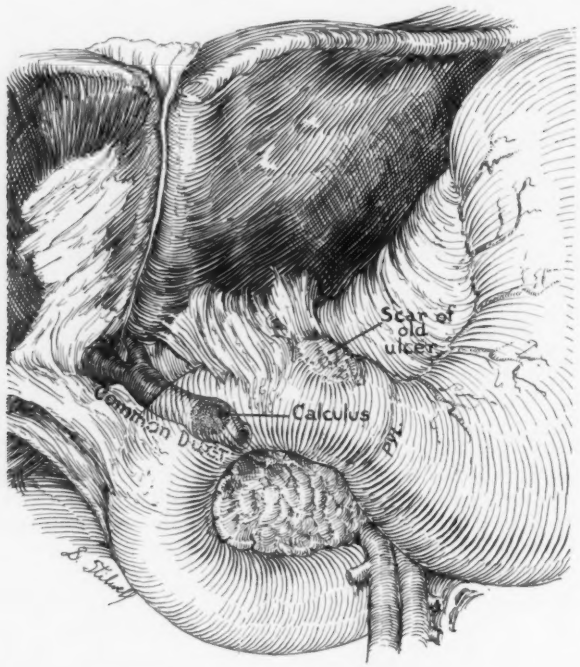

FIG. 1.—Appearance at operation (Case No. 1).

colored stool was noted and also jaundice. Since this first attack, the patient had had four or five similar episodes, the last one a few days before admission to the hospital.

Physical Examination.—The patient was in no apparent distress, but evidenced a moderate icteric tinge to the skin and sclerae. The temperature, pulse, and respirations were within normal limits. Examination of the heart and lungs was normal, and the blood pressure was 144/86. On palpating the abdomen, which was rather large, no mass could be felt and no abnormal resistance or spasm. The liver edge could be felt just below the right costal margin and there was no irregularity or abnormal firmness. Deep pressure in the whole right hypochondrium caused moderate discomfort. In other respects, the examination was normal.

Gallbladder visualization studies were carried out the second day after admission, and the radiologist reported that the gallbladder was not visualized, indicating gallbladder disease probably with cystic duct obstruction. Other laboratory tests showed a relatively normal blood picture—R.B.C., 4,360,000; W.B.C., 8,950; Hb. 98 per cent; polymorphonuclears, 83 per cent; sedimentation rate 25, and the coagulation time nine and one-half minutes. The prothrombin time was 18 seconds with the control 17

seconds. The nonprotein nitrogen was 27, blood sugar 99, and the blood cholesterol 218 mg. per cent. The icteric index was 30.0, and the blood Wassermann was negative. The urine examination was normal except for the presence of some bile and a few white blood cells in the centrifuged specimen. *Preoperative Diagnosis:* Cholecystitis with cholelithiasis and possible common duct stone.

Operation.—March 31, 1940: The abdomen was opened through an upper right rectus incision. On entering the peritoneal cavity, the omentum was found lying over the region where the gallbladder should be located. On exposing the under surface of the liver, the groove for the gallbladder was seen, but when the entire upper right quadrant was examined carefully, no gallbladder could be found. The stomach was normal, but the duodenum showed the scar of an old ulcer on the anterior superior portion. There was apparently no obstruction to the pylorus. The common duct was then visualized. Its identity was ascertained by aspiration from it of a small amount of bile. The common duct itself was not unusually distended, being at the upper limits of normal in size. When the duct was opened, it was possible to pass a uterine sound up in the hepatic ducts both to the right and to the left. When an attempt was made to pass the sound down toward the duodenum, an obstruction was met 3.5 mg. below the opening in the duct. This obstruction was caused by one small stone and a larger one, 1x1.5 cm. in diameter, somewhat irregular and black in color. This latter stone was lodged in the ampulla. After its removal, a sound could be passed into the duodenum with ease. The duct was thoroughly washed out with nomal salt solution and a No. 16 F. catheter was placed in the duct for drainage and the duct closed around this with sutures of No. 000 chromic catgut. The wound was closed in layers with catgut, except for continuous silk sutures in the skin (Fig. 1).

Postoperative Course.—Convalescence was very satisfactory until the fourth postoperative day when a hacking cough developed. This became very bothersome, and in spite of medication there were very severe paroxysms even though the chest examination remained negative. On the eighth postoperative day, after a hard cough, the patient suffered an almost complete disruption. Under pentothal sodium anesthesia, the wound was again closed, through-and-through interrupted silver wire sutures being used. Following this procedure the patient's cough for some reason stopped, and the rest of his convalescence was uneventful except for minor difficulties in voiding at times. He was discharged from the hospital May 12, 1940, with his wound healed, and ate a normal diet without any discomfort. He was last seen a few weeks ago, and showed only a small weakness at the upper end of his incision as a result of his disruption, but asymptomatic.

The second case is that of the junior author (J. K. O.):

Case C. A. G.—White, female, age 69, was admitted to the Hospital for the Women of Maryland, February 5, 1941, complaining of a dull ache in the right upper quadrant following exertion. The pain was steady and was accompanied by dyspnea; usually, but not always, the pain was relieved by resting or by the administration of spirits of niter. The pain often extended to the substernal region and sometimes radiated through the chest to the inferior angle of the right scapula. Attacks lasted from a few minutes to several hours and were often associated with nausea and vomiting and sometimes chills but never jaundice. She also noted ankle edema in the evening. The pain had never radiated to the left shoulder or down the left arm. At the time of an attack she complained of palpitation. She avoided greasy foods because of postprandial distress in the form of gaseous eructations and heartburn. All the foregoing symptoms had been recurring for two years prior to admission. She was moderately constipated and thought she had passed acholic stools. There has been no weight-loss. There was no history of typhoid fever.

Physical Examination.—Blood pressure varied between 186/80 and 150/40. The patient was orthopneic and required three pillows. There was pitting edema of both lower legs. The lungs were clear to percussion and auscultation. The heart was not

enlarged to percussion and sounds were clear, without murmurs. An occasional ventricular extrasystole was heard. There was moderate tenderness over the entire right upper abdominal quadrant, but no spasm.

Special Studies.—A gallbladder roentgenologic series was done twice, without visualization of the gallbladder. Electrocardiograms showed evidence of myocardial disease. Urine negative. Hemoglobin was 82 per cent (Sahli); fasting blood sugar 85 mg. per cent. Blood nonprotein nitrogen 30 mg. per cent. Blood Wassermann negative. The van den Bergh test showed delayed reaction.

Preoperative Course.—It was felt that the patient, unquestionably, had heart disease, and biliary disease as well. The plan was to treat her biliary disease conservatively and to concentrate on her cardiac pathology, but, on February 9, 1941, she had an attack of severe pain in the right upper quadrant; there was marked tenderness and

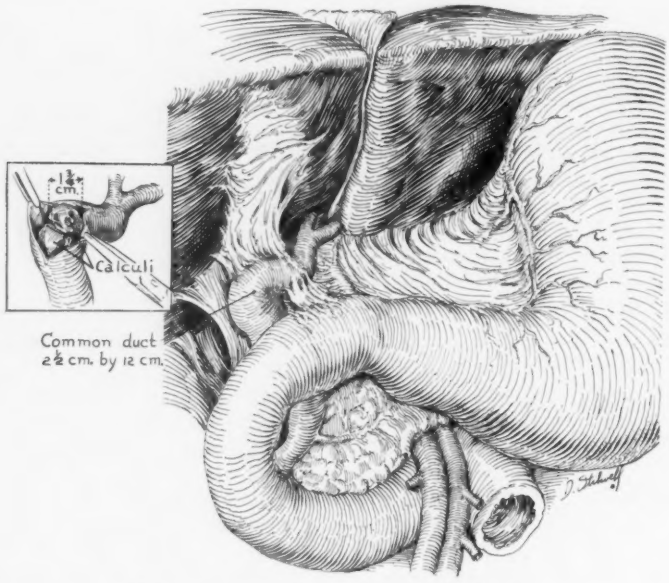

FIG. 2.—Appearance at operation (Case No. 2).

moderate spasm over the region, and the temperature rose to 103.2° F. by mouth. She pleaded for some form of relief, and we all agreed that operative intervention was indicated, even though it involved considerable risk in the face of obvious heart disease. Therefore, on February 10, 1941, a course of aminophylline gr. 1.5 t.i.d. and coramine gtt. 15 t.i.d. was begun. She had still another attack on February 12, 1941.

Operation.—February 12, 1941: The abdomen was opened through a right subcostal approach, and the liver was found enlarged to three fingers breath below the costal arch; it had the classic appearance of chronic passive congestion. Lying in a very shallow groove of the liver, where, ordinarily, the gallbladder fossa is located, was a mass of tissue surrounded by light adhesions and containing two calculi. The adherent structure was dissected free and was found to be a considerably dilated common bile duct. There was no evidence anywhere of a vestige of the gallbladder or cystic duct. The common bile duct was incised and two calculi, measuring 1.5 cm. in diameter, were removed. Thorough exploration of the dilated hepatic ducts and common bile duct was carried out with sounds and a catheter, and no other calculi were encountered. The quadrate lobe was indefinite in outline. The pancreas felt normal throughout. The stomach, pylorus, and duodenum all appeared normal. The incision into the common bile duct was closed about rubber tubing, interrupted sutures of medium silk being used. One cigarette drain was placed through the foramen of Winslow into the

lesser peritoneal cavity and another to the site of the choledochostomy. The operation was prolonged by efforts at exploration, and the patient left the operating room in only fair condition.

Postoperative Course.—Hypodermoclysis in both thighs was begun the evening of the operation. The next day the pulse became weak and rapid and the patient became slightly cyanotic. She was given oxygen, which did not greatly improve her color. Her temperature rose during the day and at noon was 103.4° F. by rectum. She was given the usual stimulants and even artificial respiration, but she died that afternoon, some 24 hours following operation.

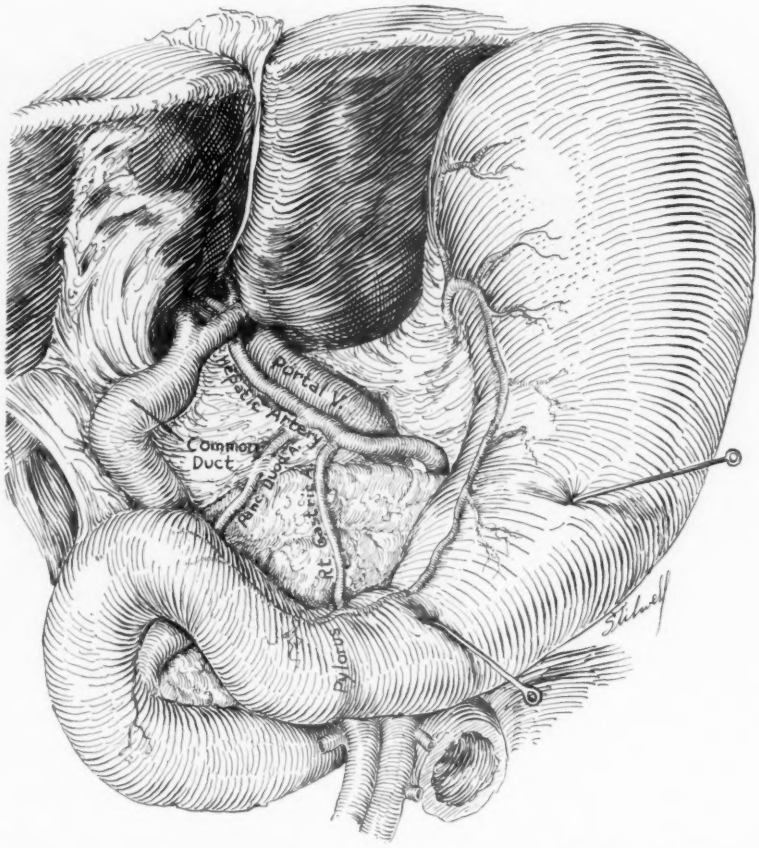

FIG. 3.—Appearance at autopsy after the stomach had been rolled downward. Note unusual relative position of hepatic artery and portal vein.

Partial Autopsy.—Rigor mortis had not set in. There was pitting edema of both lower legs. The intestine was moderately distended. There was no evidence of bile leakage. The liver still showed chronic passive congestion. The common bile duct measured 2 cm. in its greatest diameter. The liver was sectioned in every plane, and there was no sign of an intrahepatic gallbladder. The biliary duct system was carefully dissected and no evidence was found of a vestige of the cystic duct or gallbladder. The coronary vessels were sclerotic but there was no infarction. There was considerable calcification of the aortic arch. Pancreas, stomach, pylorus, and duodenum were grossly normal. Histologic study showed midzone necrosis of liver lobules with shadow-type of cell, together with many leukocytes. The large veins were engorged and contained many leukocytes. Pancreas and myocardium were normal. *Pathologic Diag-*

noses: Congenital absence of the gallbladder. Cholangitis, acute, with cholelithiasis. Arteriosclerotic heart disease, with hypertension.

There are a number of interesting surgical considerations that arise when we study the two cases herewith reported, and other similar ones collected from the literature. In the first place, when abdominal exploration is carried out in a patient with suspected gallbladder disease and no gallbladder can be found, there is the possibility of an intrahepatic gallbladder, as well as calculi in the biliary ducts. Exploration of the ducts should then be carried out, and if no calculi are found, in spite of a definite history of biliary disease, one is justified in making a reasonable attempt to find whether there is an intrahepatic gallbladder. In one of our cases, we are sure there was no intrahepatic gallbladder since the patient did not survive because of her heart condition and complete section of the liver was possible. In the other case, however, because of the fact that, on thorough exploration, there was no evidence of an intrahepatic gallbladder, as far as could be determined, and also because the patient has been completely relieved of his symptoms following the removal of the stones from the common duct, it seems quite presumptive that there was congenital absence of the gallbladder. Unfortunately, in many case reports of congenital absence of the gallbladder, the data are not given in enough detail to permit definite conclusions to be drawn. It is true, however, that in practically all the cases where the common duct was much larger than normal, stones were present.

SUMMARY

We have presented two cases of congenital absence of the gallbladder together with 46 similar cases collected from the literature after a rather exhaustive search. We have included only those cases in which no other pathologic condition was present, and have, therefore, left out a large number of cases where there was either complete or partial absence of the common and hepatic ducts as well. Some consideration has been given to the cause of absence of the gallbladder from the embryologic standpoint, and a few of the surgical aspects are discussed.

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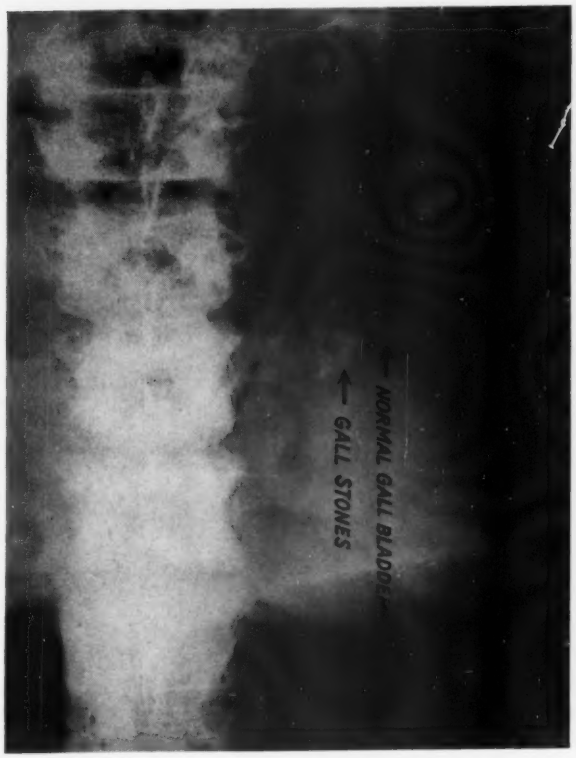

FIG. 1.—Roentgenogram showing a duplicate of the gallbladder—one containing calculi, the other apparently containing dye only.

DISCUSSION.—DR. HUGH TROUT (Roanoke, Va.): In 1933, we* reported a case of duplication of the gallbladder. At that time we looked up the literature and found there had been 34 cases reported to date. A subsequent review shows that since then 18 additional cases have been reported. So far as I know the literature does not reveal a case where the diagnosis was made roentgenologically prior to operation. We were fortunate enough to have one such case. (Figs. 1 and 2).

At operation, the two gallbladders were removed. Each was complete, with cystic duct, the cystic ducts joined just before entrance into the common duct. Boyden† demonstrated that this was the most frequent type

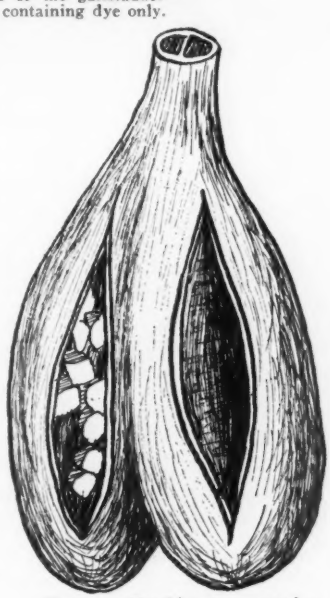

FIG. 2.—Graphic representation of roentgenographic interpretation of duplication of the gallbladder. (The artist has transposed the roentgenographic shadows.)

* Slaughter and Trout: Amer. Jour. Surg., **19**, 124-125, January, 1933.

† Boyden: Amer. Jour. Anat., **38**, 177, November, 1926.

of cystic duct relationship in the duplication of the gallbladder. Boyden, also, after a study of 19,000 autopsies done in several anatomic laboratories, showed five cases of duplication of the gallbladder, an incidence of one in 4,000. I think this condition perhaps is more frequent than has been supposed. A number of lower animals, especially cats, have been found to have duplication and accessory gallbladders. In fact, as many as four gallbladders have been found in one cat.

ANATOMY OF THE ATTACHMENTS OF THE DIAPHRAGM: THEIR RELATION TO THE PROBLEMS OF THE SURGERY OF DIAPHRAGMATIC HERNIA*

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Numerous studies of the etiology, diagnosis, and treatment of diaphragmatic hernia have appeared in recent years,[7, 8, 10, 13, 17, 21, 22] and in several of them the literature has been fully reviewed. Nothing would be gained at this time by another review of that type; consequently, the scope of this contribution is limited to an account of some new observations on the anatomy of the attachments of the diaphragm, comments on the surgical significance of these observations, and the report of two methods that we think useful in the repair of unusually large defects in this septum, regardless of their etiology.

Anatomy.—The usual description of the peripheral attachments or origins of the diaphragm[5, 9, 20, 24] may be summarized as follows: (1) The anterior or sternal portion is attached to the xiphoid process and the adjacent aponeurosis of the transversus abdominis or to a tendinous arch extending from the xiphoid to the cartilages of the fifth and sixth ribs (Fig. 1 a). (2) The lateral or costal portion arises from the posterior surfaces of the cartilages of the seventh, eighth, and ninth ribs and from the osseous extremities of the tenth, eleventh, and twelfth ribs. The segment attaching to the seventh, eighth, and ninth ribs is said to interdigitate with the transversus abdominis, and the more posterior portion is described as arising in part from tendinous arches that bridge the origins of the transversus abdominis in the last three interspaces (Fig. 1 a). (3) The posterior or lumbar segment (Fig. 1 b) arises by means of three pairs of crura from the bodies and transverse processes of the upper lumbar vertebrae and from the arcuate ligaments. Only the lateral crus concerns us in this discussion. It is said to be attached to the bodies of the first and second lumbar vertebrae and to the medial and lateral lumbocostal arches (arcuate ligaments) which are described as fibrous condensations of the fascia covering the psoas and quadratus lumborum muscles. The medial arch (internal arcuate ligament) is said to be attached at one extremity to the body of the second lumbar vertebra and at the other to the corresponding transverse process. It bridges the bellies of the psoas muscles. The lateral arch (external arcuate ligament) bridges the belly of the quadratus lumborum and is said to be attached at its medial end to the tip of the second lumbar transverse process and at its lateral end usually to the tip of the twelfth rib.

Our artist, Mr. W. Branks Stewart, found, when he attempted to make drawings of the diaphragm from cadaveric dissections for Doctors Baker

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

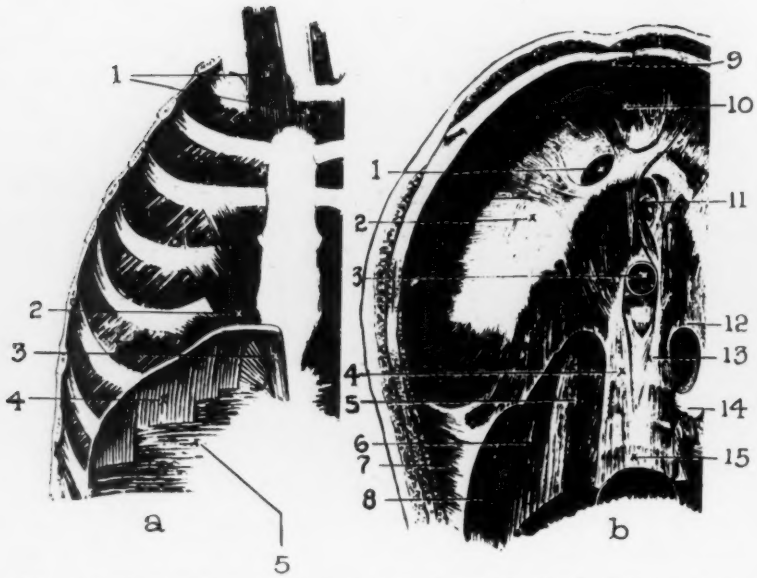


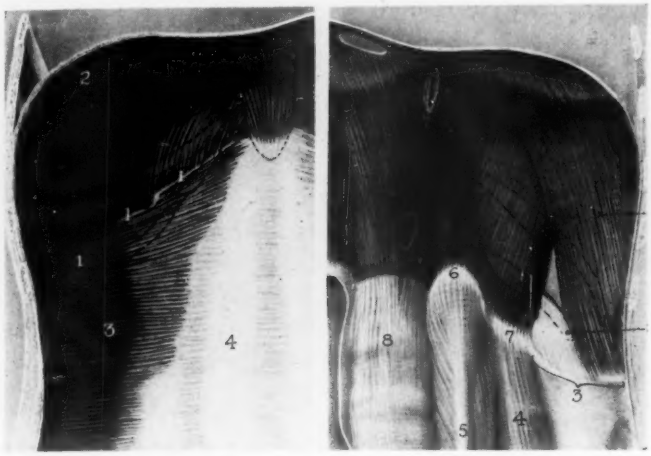
FIG. 1.—Textbook illustration of anatomy of diaphragm (Modified from Morris' *Human Anatomy*).

(a)
(1) Sternothyroid
(2) Transversus thoracis
(3) Sternal origin of diaphragm
(4) Costal origin of diaphragm

(b)
(1) Opening for vena cava inferior
(2) Right division of tendon
(3) Aorta
(4) Right crus
(5) Psoas minor
(6) Psoas major
(7) Transversus abdominis
(8) Quadratus lumborum
(9) Sternal origin
(10) Middle division of tendon
(11) Esophagus
(12) Medial lumbocostal arch
(13) Left crus
(14) Transverse process of second lumbar vertebra
(15) Fourth lumbar vertebra

and Burns, that he could not harmonize this description with his specimens. This fact led Doctor Baker to undertake a series of dissections of the diaphragmatic attachments in human cadavers. These dissections revealed the fact that while the above description is approximately correct insofar as the ultimate points of bony attachment of the diaphragm are concerned, it fails to give a true picture of the attachments of the costal segment and of the lateral portion of the lumbar segment in their relations to the transversus abdominis muscle and to the lumbar fascia. We find that the attachments of the costal portion of the diaphragm and those of the transversus abdominis to the costal cartilages and ribs (Fig. 2 a) are so intimately blended anteriorly (in the region of the seventh, eighth, and ninth cartilages) that they are inseparable, and that posteriorly (tenth, eleventh, and twelfth ribs) the two muscles are united by a common aponeurosis which becomes progressively wider as it is traced backward to the lateral margin of the quadratus lum-

borum where it blends with the lumbodorsal fascia (Fig. 2 b). This common aponeurosis attaches to the tips of the tenth and eleventh ribs but only indirectly to the twelfth. Medial to the tip of the twelfth rib, it blends with the fascia that bridges the triangular defect in the musculature of the



a b

FIG. 2.—Attachments of the diaphragm as revealed by authors' dissections.
(a)
(1) Common aponeurosis and transversus abdominis attached to posterior surfaces of costal cartilages and tips of ribs
(2) Anterolateral portion of the costal segment of the diaphragm
(3) Transversus abdominis
(4) Posterior sheath of rectus abdominis
(b)
(1) Posterolateral portion of costal segment of diaphragm
(2) Tip of twelfth rib
(3) Fusion of the common aponeurosis of the transversus abdominis and the diaphragm with the lumbodorsal fascia
(4) Quadratus lumborum
(5) Psoas muscles
(6) and (7) Condensations of the anterior layer of the lumbodorsal fascia giving attachment to the diaphragm (medial and lateral lumbocostal arches)
(8) Prevertebral fascia

diaphragm that represents the former site of the pleuroperitoneal hiatus (foramen of Bochdalek). In effect, therefore, the diaphragm and the transversus abdominis are continuous with each other, a fact which can be readily and graphically demonstrated by freeing their attachments to the costal arch, thus converting the two muscles and their common aponeurosis into a continuous fibromuscular sheet which together with the rectus sheath and the lumbar fascia enclose the abdominal cavity (Fig. 4).

Medial to the former site of the hiatus pleuroperitonealis is the lateral margin of the lumbar segment of the diaphragm (Fig. 2 b). Dissection of its attachments reveals a state of affairs quite similar to that seen in the costal portion. The arcuate ligaments, to which the lateral crus attaches, are found to be simply condensations of the lumbopsoas fascia attaching only indirectly, through the lumbodorsal fascia, to the tip of the twelfth rib and the transverse process of the second lumbar vertebra. The lateral attachment of the lateral crus is, therefore, really to that layer of the lumbar fascia which covers the

anterior surfaces of the quadratus lumborum and psoas muscles (Fig. 2 b) and Fig. 3). That it is actually continuous with this fascia is amply attested by the fact that muscle fibers have actually been seen to extend from the diaphragm through the arcuate ligaments and into this fascia. In effect, therefore, the diaphragm is continuous with the inner fibromuscular layer of the abdominal wall.

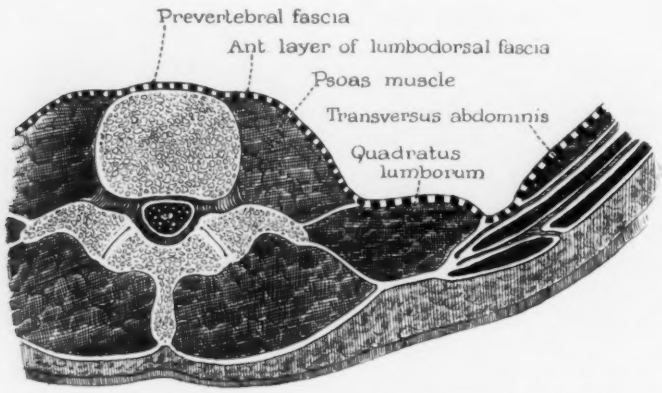


FIG. 3.—Cross-section below the level of the attachment of the diaphragm showing the anterior layer of the lumbodorsal fascia which is continuous with the lateral portion of the lumbar segment of the diaphragm. Note that this layer is attached only indirectly to the transverse process of the vertebra.

Since making this study we have been interested to find that Sir Arthur Keith[14] has observed the continuity of the diaphragm with the transversus abdominis and posterior lamina of the rectus sheath in the developmental stage, and that, in 1676, Caspar Bartholin, son of Thomas,[2] described the diaphragm and the transversus abdominis muscles combined as a trigastric muscle.

Embryology.—It is very tempting, after studying these dissections, to think of the diaphragm as representing the inner layer of the thoracic portion of the coelomic cavity stripped from the surface and forced downward by the descent of the thoracic viscera, but unfortunately this is not in accord with the known facts. The most probable explanation is as follows: The diaphragm, which is a late development in the evolutionary process, being found only in mammals, is formed from three different sources, two of which are paired. The three parts develop independently and on different time schedules: (1) The anteromedial portion develops from the transverse septum; (2) the posterolateral portions from the pleuroperitoneal membranes; and (3) the lumbar portion from the dorsal mesogastrium. At about the seventh or eighth week of fetal life, these segments fuse to form a single fibrous septum which later is converted partially into muscle. Shortly after this has taken place, the liver grows so rapidly that it expands the upper abdomen faster than the diaphragm can grow. Consequently, a portion of the inner wall of the abdominal cavity is pulled inward to become the peripheral margin of the diaphragm[1, 23] (Fig. 5). This probably accounts for the continuity of the diaphragm with the inner layer of the abdominal wall.

Diaphragmatic Hernia.—In view of the complex origin of the diaphragm, it is not surprising that we find that congenital openings not infrequently occur. A review of the reported defects is beyond the scope of this paper. For our purposes, it is sufficient to say that any part or all of one leaf of the

FIG. 4.—The right side of the diaphragm, the transversus abdominis, and their common aponeurosis exposed by removal of parts of the thoracic and abdominal walls.
(1) Diaphragm
(2) Common aponeurosis of diaphragm and transversus abdominis
(3) Transversus abdominis

diaphragm may be found missing. Very large defects are most common in the posterior portion and on the left side. Complete bilateral absence of the lumbar segments has been reported.[8] Infection and trauma may also, on occasion, cause very large defects.

Most openings in the diaphragm may be closed by simple suture without great tension (especially if the phrenic nerve is crushed as a preliminary step) because the convexity of the diaphragm affords a considerable amount of slack, but when the defect is very large some means of supplementing the available amount of tissue or of diminishing the anteroposterior diameter of the thorax may be necessary. This is especially true when the hiatus is a marginal one, as in hernia through a persistent pleuroperitoneal foramen. Free fascial grafts may be used but are subject to the disadvantage that they cannot be placed in a satisfactorily vascular bed. It seems desirable, therefore, to use some form of sliding or pedunculated flap. When the common attachments of the transversus abdominis and the diaphragm have been dissected from their costal attachments, one is immediately impressed by the fact that the diaphragm has been augmented by an additional segment equal

to almost one-half its total area (Fig. 4), and that the entire structure can easily be drawn down below the costal arch, even in the fixed cadaver. The following procedure (which has been performed only on the cadaver) is, therefore, proposed for very large defects in the anterior and anterolateral portions of the diaphragm.

A subcostal incision is made about one inch below the costal arch, extending from the lateral margin of the rectus sheath to about the tip of the tenth or eleventh rib. This incision is carried down through the external and internal oblique muscles, exposing the transversus abdominis. The internal oblique is then separated from the anterior surface of the transversus anteromedially to the attachment of the latter to the posterior rectus sheath. The costal arch is retracted anteriorly and superiorly so that, by blunt dissection, the common attachment of the transversus abdominis and the diaphragm is exposed. By careful sharp dissection with the blade of the knife directed toward the ribs, this aponeurosis is dissected from its costochondral attachment for the full length of the incision (Fig. 6 B). The pleural cavity is usually entered during this procedure, and this opening should also be enlarged to the full length of the incision, after which it is possible to pull the diaphragm down well below the costal arch. The contents of the hernia are then fully exposed, making the freeing of adhesions and the replacement of the viscera in the abdominal cavity comparatively easy. The defect can then be closed with adequate overlapping of the edges and without tension even if as much as one-third of the leaf is absent (Fig. 6 C and D). Part of the transversus abdominis now slides into the chest cavity and becomes a part of the diaphragm. The anterior surface of the transversus abdominis is then sutured securely to the costal margin, thus closing the thoracic cavity (Fig. 7). If, after this has been done, the abdominal cavity should be too much reduced in capacity, the transversus abdominis may be detached from the posterior sheath of the rectus muscle, and in addition, if necessary, it may be divided by an incision parallel to the costal arch and well below the skin incision, thus permitting it to slide freely into the thoracic cavity without reducing the capacity of the abdomen. If the peritoneum should be opened during this maneuver, either by accident or by design, the resulting defect can readily be covered with the omentum or, on the right side, with the falciform ligament. It is probable that more than one-half the area of one leaf of the diaphragm can be supplied by this method.

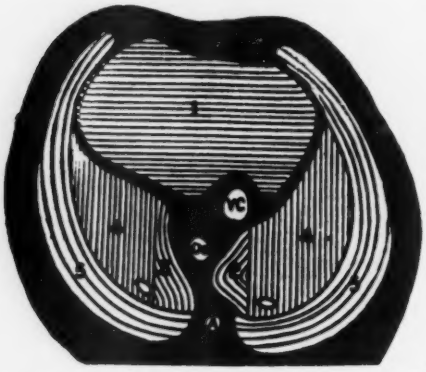


FIG. 5.—Diagram showing the origin of the diaphragm (after Broman): (1) Septum transversum; (2, 3) derivatives of mesentery; (4, 4) derivatives of pleuroperitoneal membrane; (5, 5) parts derived from the body walls; A, aorta; Oe, esophagus; VC, inferior vena cava.

Large marginal defects rarely occur in the anterior portion of the

diaphragm, but it seems to us that this approach would provide an ideal method of closure for such cases.

Very large defects in the diaphragm are much more common in its posterior than in its anterior portion, largely because of the frequency of

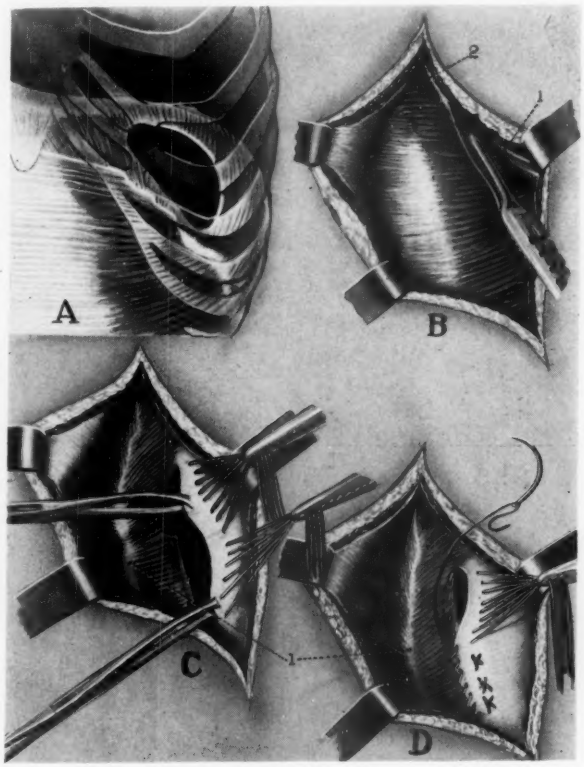


FIG. 6.—Operative procedure proposed for large defects in the anterior portion of the diaphragm.
A. Large defect in anterior portion of diaphragm
B. Common attachment of transversus abdominis and diaphragm being dissected from its costal attachment
(1) Costal arch retracted upward
(2) Common aponeurosis of the transversus abdominis and diaphragm
C and D. Defect in diaphragm pulled down below costal arch and closed with overlapping of the edges
(1) Common aponeurosis of transversus abdominis and diaphragm

persistence of the pleuroperitoneal hiatus, but the procedure described above is not suitable for such cases, for the lumbar attachments of the diaphragm are quite inaccessible from an anterior transthoracic incision. A posterior approach embodying the same principles is not practicable, for the lumbar fascia cannot be mobilized as can the transversus abdominis. However, a suitable sheet of muscle to close the defect can be obtained from the latissimus dorsi, as was done in the following case:

Case Report.—B. M., white, female, age 19, presented herself to Dr. Frank Brock, February 23, 1936, complaining of attacks of pain in the epigastrium and right upper

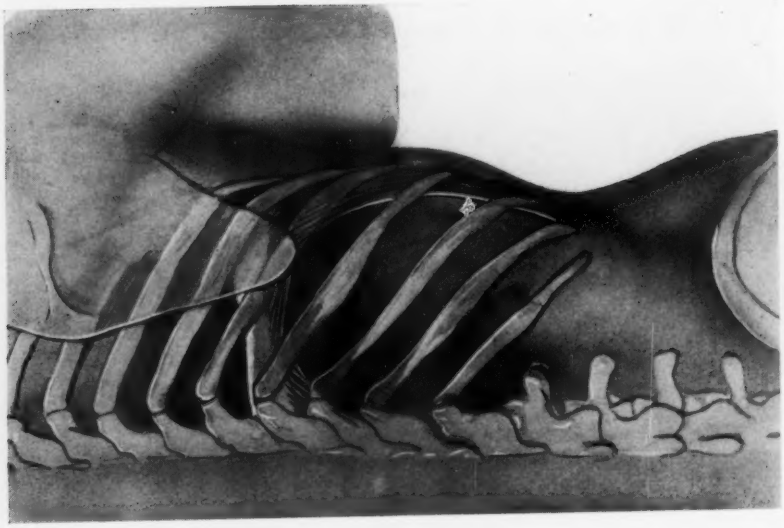


FIG. 8.—Case of Miss B. M.: Complete absence of the posterolateral segment of the right leaf of the diaphragm.

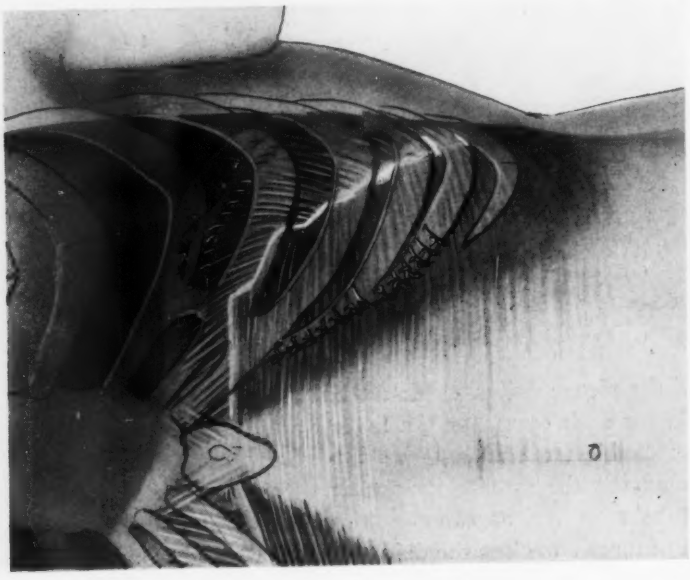


FIG. 7.—Transversus abdominis sutured to costal arch. Note that common aponeurosis of the transversus abdominis and the diaphragm now lies well above costal arch and that a portion of the transversus abdominis has become a part of the left leaf of the diaphragm.

quadrant of the abdomen associated with nausea, vomiting, and fever; duration, about five months. Her mother reported that she had suffered from severe "smothering spells" until she was four and one-half months old.

Examination revealed the presence of a huge right diaphragmatic hernia. Roentgenograms showed no evidence of the right leaf of the diaphragm.

On March 18, 1936, Doctor Brock and one of us (J. D. R.) attempted to close the hernia through an anterior transabdominal approach. When the abdomen was opened, the patient took a deep breath and the entire right lobe of the liver and most of the right half of the colon disappeared into the thoracic cavity. The pleuroperitoneal diaphragm was found to be intact but the fibromuscular septum was represented only by an anterolateral crescentic flap about three inches wide at its widest point (Fig. 8). The posteromedial portion of the diaphragm including the lateral crus was absent. Whether or not the medial crura were missing or merely displaced to the left of the midline was not determined. There were no adhesions. The opening was closed under great tension and recurrence took place in about one and one-half months.

On April 15, 1937, the hernia was repaired successfully by the following procedure: An oblique incision was made over the tenth rib. This rib was excised subperiosteally and the thoraco-abdominal cavity was entered by an incision through the rib bed. It was found that the pleuroperitoneal diaphragm had been ruptured at the time of recurrence of the hernia, and that now the pleural and peritoneal cavities were continuous. Curiously enough, almost no adhesions were found. A careful review of the situation made it clear that the defect in the diaphragm could not be closed without tension, unless some other substance or structure was employed to help bridge the gap. The lower portion of the divided latissimus dorsi seemed to answer this need. Accordingly, it was mobilized, turned in over the eleventh rib, and its free margin sutured to the freely exposed muscle of the posterior margin of the diaphragm by means of "U" sutures of chromicized catgut (Fig. 9). The thoracic cavity was closed by suturing the ninth intercostal bundle and the upper cut margin of the latissimus dorsi to the dorsal surface of the lower portion of the latissimus dorsi (Fig. 10). The result has been quite satisfactory, as can be seen from roentgenograms made three years after operation (Figs. 11 and 12). During this interval the patient has completed a nursing course and is now actively engaged in the practice of her profession.

This procedure was not planned in advance, and we suggest the following improvements: (1) It would probably be better to resect the eleventh rib instead of the tenth. (2) If the latissimus dorsi were divided about two inches above the rib to be resected, a more liberal muscle flap would be provided.

CONCLUSIONS

(1) The diaphragm is continuous with the inner fibromuscular layer of the abdominal wall, that is, the posterior sheath of the rectus muscles, the transversus abdominis muscles, and the anterior layer of the lumbar fascia.

(2) The continuity of the diaphragm with the transversus abdominis makes it possible to use the latter in the repair of large anterior defects in the former. A proposed method of procedure is described and illustrated.

(3) A clinically successful method of repairing large defects in the posterior half of the diaphragm by means of a sliding fibromuscular flap is reported.

FIG. 9.—Case of Miss B. M.: Defect closed by substituting a part of the latissimus dorsi for the missing portion of the diaphragm.

FIG. 10.—Case of Miss B. M.: Chest cavity closed by suturing ninth intercostal bundle and upper portion of latissimus dorsi to the anterior surface of the lower portion of the latter.

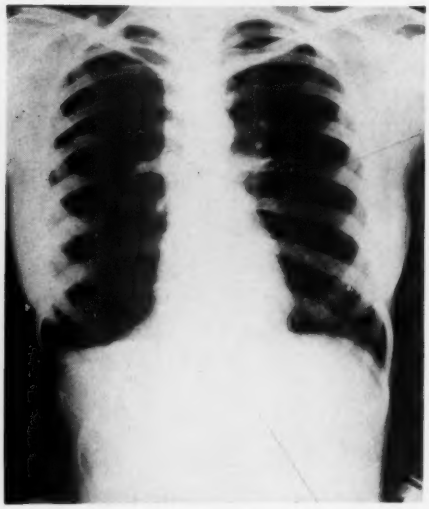


FIG. 11.—Case of Miss B. M.: Anteroposterior view of chest three years after operation.

FIG. 12.—Case of Miss B. M.: Lateral view of chest three years after operation.

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AN OPERATION FOR THE CURE OF INGUINAL HERNIA*

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The operation which is about to be described is a combination and modification of many of the different technics which have been employed during the last 25 years. I have used the same repair, exclusively, in 293 operations during the past five years, and there have been only 2.38 per cent recurrences. In 85 per cent of the recurrences, the patients either developed post operative pneumonia associated with a severe cough, or there was a wound infection.

Table I

SYNOPSIS OF RECURRENCES FOLLOWING 293 HERNIOPLASTIES

No. of Cases	Type of Hernia	No. of Recurrences	Percentage of Recurrences
171	Indirect inguinal herniae	3	
53	Direct inguinal herniae	2	
32	Indirect inguinal herniae, with associate direct hernia	1	
37	Recurrent inguinal hernia	1	
Total 293		Total 7	2.38%

The incision is the customary oblique inguinal incision. The aponeurosis of the external oblique is widely exposed and divided in the center of the superficial inguinal ring (Fig. 1) by the aid of a grooved director, care being taken not to injure the ilio-inguinal nerve.

The cord is freed, and its fibrous attachments, which are so often found in the region of the pubic bone, are divided (Fig. 2), thus allowing the cord to be entirely lifted from the inguinal canal.

It is important that the entire inguinal ligament is freed of all adhesions and adipose tissue. The superior layer of the aponeurosis of the external oblique is (Fig. 3) dissected up to its fusion with the falx inguinalis.

The indirect inguinal sac, identified on the anterior surface of the cord, is isolated (Fig. 4) and opened, and then dissected free from the cord (Fig. 5). This dissection is carried upward as far as possible, so that a portion of the abdominal peritoneum is pulled downward and included in the hernial sac. A careful search is made at this time for an associated direct hernia. The sac is closed (Fig. 6), as high as possible, with No. 00 Plastigut,† and after the sac has been cut away, the ligated stump is anchored high under the internal oblique muscle.

In the case of a direct hernia, the sac is freed (Fig. 7), opened, resected, and closed with a continuous suture of No. 00 Plastigut and the operation is completed in the same manner as an indirect hernia.

In the case of a large direct hernia, it is often desirable to divide the inferior epigastric vessels, as this will facilitate the exposure and closure of the sac. An oblique incision is then carried through the internal oblique muscle

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

† A synthetic product made by the Plastigut Foundation, Peoria, Illinois.

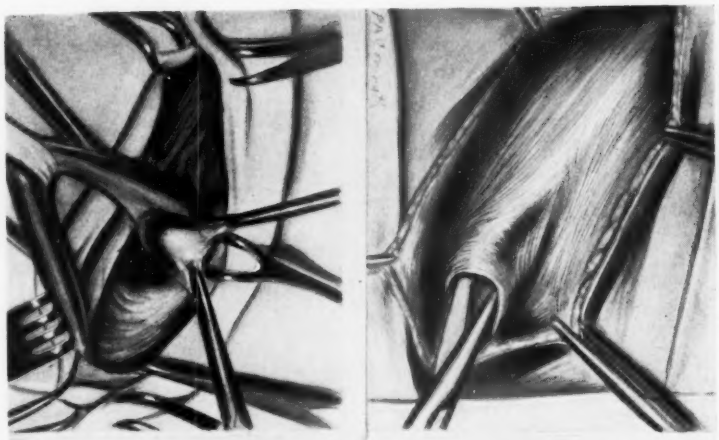
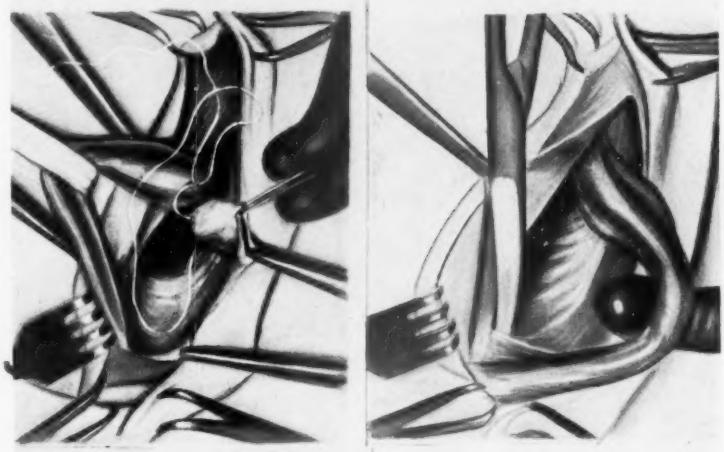


FIG. 1



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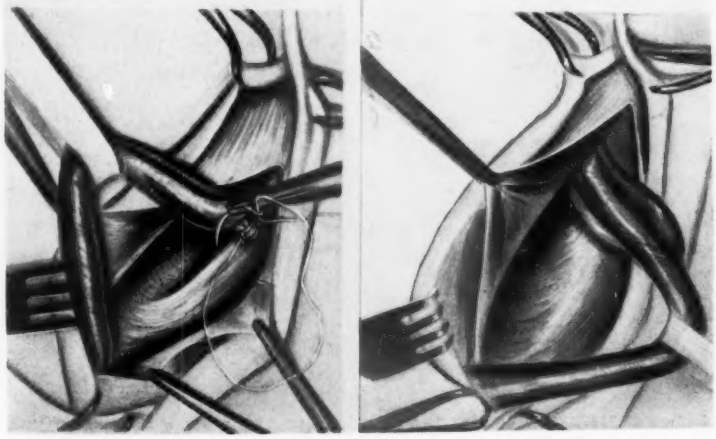

FIG. 3

FIG. 4

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FIG. 6

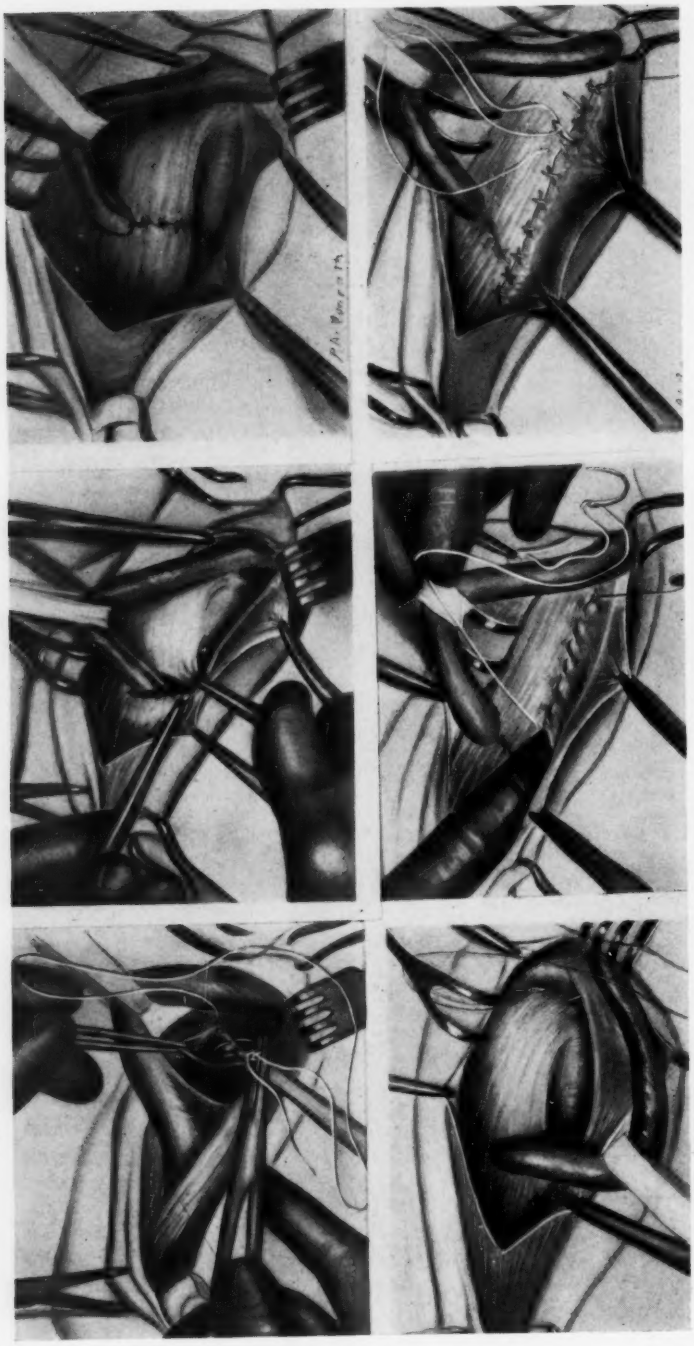

FIG. 9

FIG. 12

FIG. 8

FIG. 11

FIG. 7

FIG. 10

FIG. 15

FIG. 18

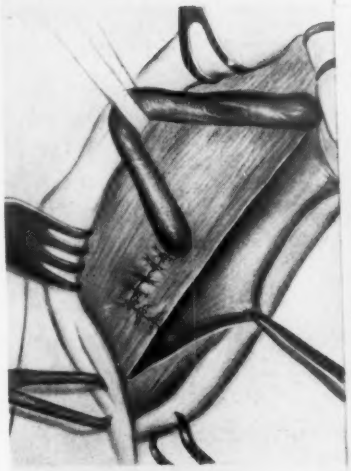

FIG. 14

FIG. 17

FIG. 13

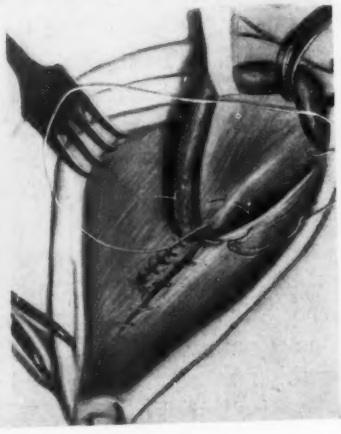

FIG. 16

close to the attachment to its aponeurosis (Fig. 8), upward and laterally, for a distance of one inch, beginning at the abdominal inguinal ring. The cord is then displaced upward and laterally through this incision, and (Fig. 9) the fibers of the internal oblique muscle are sutured around the cord with No. 0000 Plastigut, thus forming a new abdominal inguinal ring.

Later during the operation, a flap is cut in the superior reflection of the aponeurosis of the external oblique (Fig. 13) and sutured around the cord, thus completing a combined abdominal and superficial inguinal ring. The advantage of this procedure is that there will be no weakness in the subsequent repair, and no strangulation of the cord by too tight sutures, as the cord will not have to be taken into any further consideration in this operation.

The operation is effected with continuous No. 00 Plastigut sutures, as this reduces the number of knots and reduces the incidence of serum formation. A small heavy Mayo needle is used. The first suture (Fig. 10) is passed through the most medial portion of the falx inguinalis and is carried deeply into the periosteum of the pubic bone, and through the fibers of the inguinal ligament. This suture is tied and a clamp is placed on the free end of the suture. This suture is continued laterally until all of the falx inguinalis and internal oblique muscle (Fig. 11) is sutured to the shelving edge of the inguinal ligament. When it has reached the lateral limit of the incision the suture is locked, and a (Fig. 12) second row of sutures is placed in the reverse direction, care being taken to place the second row in such a manner that a different level of fibers are grasped in the inguinal ligament. These sutures will have the appearance of cross-stitching. This suture is then continued to the starting point, and tied to the suture which was originally left free.

A flap A.B.C. is cut in the superior reflection of the aponeurosis of the external oblique (Fig. 13), one and one-half inches lateral to the cord, so that when it is brought around the cord and sutured (Fig. 14) it will complete a new combined abdomino-superficial inguinal ring. The superior reflection of the aponeurosis of the external oblique is now sutured (Fig. 15) to the shelving edge of the inguinal ligament, beginning at its most medial attachment. This suture is tied, the free end is clamped, and when the lateral limit of the incision in the aponeurosis is reached, the suture is locked, and is continued medially, imbricating the inferior layer of the aponeurosis of the external oblique over the superior layer, until this same suture reaches its starting point, where it is tied to the suture that was originally left free for this purpose (Fig. 16). It will be noted that there are only two knots in the actual repair, but still there are four rows of sutures.

The cord is completely transplanted throughout (Fig. 17), lying directly under the superficial fascia and the skin. Scarpa's fascia is closed with a continuous suture of No. 0000 Plastigut (Fig. 18), care being taken to suture this fascia securely around the cord to the underlying aponeurosis, so as to avoid all dead spaces. The skin is closed with Michael clips, after the wound has been thoroughly cleansed with some aqueous antiseptic or a sterile saline solution.

A METHOD OF DISPOSAL OF THE SAC IN OPERATIONS FOR OBLIQUE INGUINAL HERNIA *

JOSEPH D. COLLINS, M.D.

PORTSMOUTH, VA.

DURING RECENT YEARS many articles have appeared in surgical literature dealing with the problem of recurrence following operations for inguinal hernia. Many modifications of the original operations of Bassini and Halsted have been devised, all of which have for their object the reducing of the incidence of recurrence. As far as I have been able to observe, most of these improvements in technic have to do with closure of the inguinal canal. I do not wish, in the slightest degree, to minimize the importance of adequate plastic repair of the canal, but I believe that not enough attention is being given to the disposal of the sac.

In 1919, LaRoque[12] described his operation for the removal of the sac from within the abdomen. Later, in 1924[13] and 1932,[14] he reemphasized the value of this procedure in the various types of herniae. This operation has not gained the popularity it deserves. In 1937, Williams[18] presented a paper in which he discussed the advantages of the abdominal approach to inguinal herniae, as advocated by LaRoque. More recently, Willis,[19] also Harrison,[9] published papers in which attention was called to the importance of the sac in the cure of hernia. With these exceptions little or no mention has been made of the sac in suggestions for improved technic. Apparently the rôle that the sac plays in the recurrence of a hernia is considered unimportant.

Whatever else may be necessary as a part of the operative procedure for the cure of hernia, the complete removal of the sac from the inguinal canal is essential. The usual practice of ligating the sac as high as possible frequently leaves in the internal ring a process of peritoneum in the form of a cone, with the apex directed toward the canal. This can easily be demonstrated by having a patient, who is being operated upon under local anesthesia, cough or strain, when the bulging peritoneum can be felt by the examining finger. An intraperitoneal dimple is created just proximal to the ligation. This point may well be the beginning of a recurrence.

When the internal ring is unusually large and the neck of the sac is of unusual width, it is technically almost impossible to ligate the sac above the ring. There is an added danger that the ligature may become loosened or even slip off the stump of peritoneum during the postoperative period, because of excessive vomiting or coughing.

If, during an attempt at high dissection, in order to secure a high ligation, the sac, unfortunately, splits up through the ring, or is accidentally buttonholed at or above the ring, the purpose of the high ligation may be defeated. In the description of the technic of hernia operations the importance

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

of high ligation is always stressed, but it must be admitted that the so-called high ligation, as generally practiced, is often inadequate. In my opinion, a method of disposal of the sac that will eliminate the dimple or cone-shaped process of peritoneum will contribute, in a large measure, to the prevention of recurrence. If the redundant parietal peritoneum can be tightened over the hernial fossa until it is taut, as suggested by LaRoque, it will certainly constitute the first line of defense against a recurrence of the hernia.

The older surgeons were fully aware of the importance of the complete removal of the sac. Fifty years ago, Bennett[6] said that the essential requirements of any properly devised operation were: "(1) The provision of an effectual barrier across the internal aspects of the aperture through which the hernia escapes; and (2) The abolition of the hernial fossa in the peritoneum over the abdominal orifice of the canal." He further stated that all operations which leave any portion of the sac in the ring or canal are faulty in principle and defective in practice. In my opinion these fundamental principles still hold true.

Before Bassini[3, 4] made his monumental contribution to the treatment of hernia most surgical authorities considered the complete removal of the sac of primary importance, the canal being regarded as only secondary. As Bassini's methods were not immediately adopted, a number of years elapsed before the older ideas were abandoned. During this period many surgeons devised operations in which the sac alone was the chief consideration. Among them were Macewen,[15] Ball,[1] Phelps,[16] Barker,[2] Kocher,[10, 11] Baxter,[5] Terrillon,[17] and Bishop.[7] With the general acceptance of the principles of Bassini these operations became obsolete. However, the operation of Kocher, I believe, merits review in detail.

In 1892, Kocher published a paper in which he described his "new" method of operation for the radical cure of inguinal hernia. In this operation, which he called the "transposition-invagination" method, the sac was freed from the cord up to the upper border of the external ring, while strong traction was made on the sac in order to expose its highest part. After reducing its contents, the fundus of the unopened sac was grasped by a narrow, curved dressing forceps and invaginated backward through the inguinal canal, the points of the forceps being kept close behind the anterior wall until they entered the internal ring where they were projected forward through a previously made incision in the abdominal wall well above the level of the internal ring. The fundus of the inverted sac was now forcibly drawn through the opening in the abdominal wall, transfixed, ligated, and excised distal to the ligature. The stump of the sac was then fixed with sutures to the outer surface of the aponeurosis of the external oblique. This disposal of the sac is open to objection, theoretically at least, in that a process of peritoneum is left protruding through the abdominal wall which might conceivably become the site of a ventral hernia. However that may be, his results were excellent, for in this paper he reported 76 cases operated upon with only two recurrences (2.7 per cent), and they occurred in patients who had exceptionally large herniae.

In his "Text Book of Operative Surgery," published some years later, Kocher modified his earlier operation by dropping the stump of the sac back into the abdomen and suturing the opening in the peritoneum and the muscles of the abdominal wall. In those cases where the sac could not be invaginated, either on account of its being too short or too thin, he did what he called

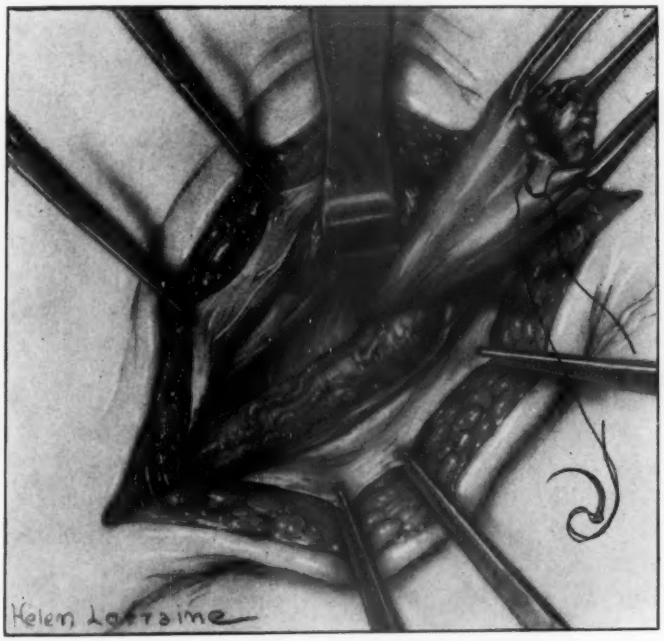

FIG. 1.—Encircling suture placed in open end of sac, tied loosely with a single knot.

"lateral transposition." In this maneuver the sac was grasped with a curved forceps and pushed up the inguinal canal immediately behind the anterior wall as far as the internal ring where it was protruded through a small opening in the aponeurosis and forcibly pulled out. The neck of the sac was ligated, excised distal to the ligature, and the stump allowed to retract into the abdomen. The small opening in the aponeurosis was then sutured.

Kocher was very enthusiastic about his operation, reporting that in his own clinic at Berne, between the years 1896 and 1900, he obtained 97.7 per cent cures—only 2.3 per cent recurrences in 73 cases. He stated further that he considered the cures to be permanent as they had been operated upon over five years. He apparently derived much satisfaction in comparing his results with those of Bassini, who reported, in a similar series of cases, only 90.1 per cent cures, or 9.9 per cent recurrences.

The results obtained by Kocher compare more than favorably with those of the present day. According to Erdman,[8] "from a number of the largest and best surgical clinics, follow-up reports, based on actual examinations, show from 3 to 7 per cent recurrences after operations for oblique herniae,

and from 15 to 30 per cent after operations for direct herniae. Probably throughout the hospitals of the country the actual rate is even higher."

Kocher's statistics are even more impressive when it is recalled that he did not employ the Bassini method of closing the canal, the treatment of the sac being the principal step in his operation. He simply introduced a series of interrupted sutures beneath the aponeurosis of the external oblique where it forms the anterior wall of the canal, that portion in the grasp of the sutures

FIG. 2.—Index finger introduced through neck of sac impinging on anterior abdominal wall, the internal oblique and transversalis muscles being separated over tip of finger.

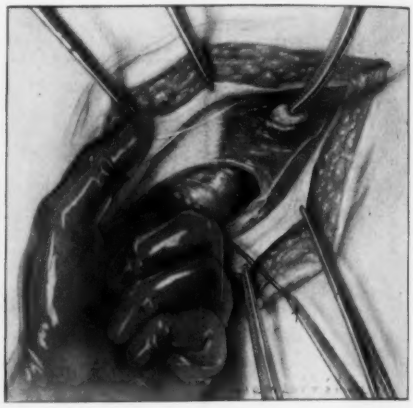

FIG. 3.—Curved Kelly forceps being used to make puncture opening in transversalis fascia and peritoneum. Forceps is then pushed downward through neck of sac.

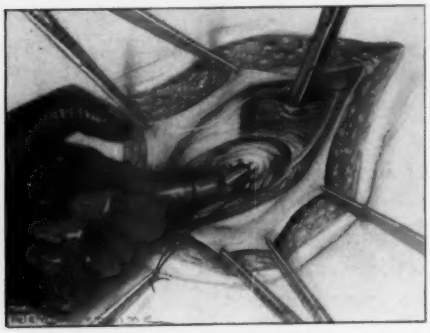

FIG. 4.—Forceps emerging from mouth of sac in contact with tip of finger.

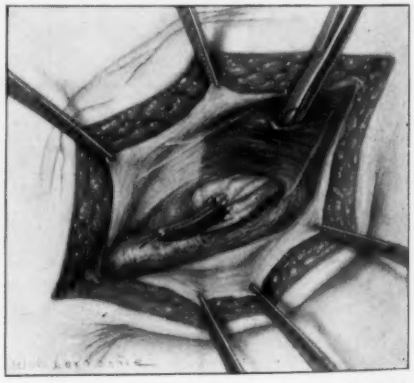

FIG. 5.—Suture in mouth of sac has been tied around the forceps, the ends of suture being engaged in closed forceps.

being depressed with the finger so that when the sutures were tied two parallel folds were approximated, thus tightening the aponeurosis and eliminating any redundancy that might be present. The pillars of the external ring were brought together with interrupted sutures closing the ring as tightly over the cord as was possible without interfering with its circulation. He considered Bassini's operation unnecessary in uncomplicated herniae and resorted to it only in instances of strangulation, those complicated by inflammatory thickening of the sac, with visceral adhesions, and in direct herniae.

To-day, the fundamental principles of the Bassini operation are universally accepted and practiced, and Kocher's operation has been forgotten. It is probably true that, in the concentration of effort to find better methods of closing the inguinal canal, the importance of adequate removal of the sac has been overlooked. It is logical to conclude that if the modern methods of closure are preceded by a more complete removal of the sac from the canal more permanent cures would result.

For several years I have employed a method of disposing of the sac which, in my opinion, complies with the postulates of Bennett.[6] It throws an effectual barrier across the internal aspects of the aperture through which the hernia escapes, and also abolishes the hernial fossa in the peritoneum over the abdominal orifice of the canal. It utilizes the principles of Kocher's operation, with important modifications. I must confess, however, that my knowledge of Kocher's operation was acquired during my search of the literature in connection with the preparation of this paper.

TECHNIC OF DISPOSAL OF THE SAC

The inguinal canal having been opened by incising the aponeurosis of the external oblique, the sac is dissected upwards from its bed and freed from its attachments to the cord and cremaster muscle. Any adherent abdominal viscera is released and allowed to drop back into the abdominal cavity. An over-and-over silk suture is passed around the edge of the open end of the sac, completely encircling it, and this suture is tied loosely with a single knot and laid aside (Fig. 1). The index finger is then inserted into the open mouth of the sac and passed through its neck into the peritoneal cavity, where it is made to impinge firmly against the anterior abdominal wall at a point two inches above the upper border of the internal ring. The fibers of the internal oblique and transversalis muscles over the impinging finger are then separated down to the transversalis fascia for a distance of an inch or an inch and a half (Fig. 2). This separation is held apart by retractors. With a curved Kelly forceps, a puncture is made through the transversalis fascia and peritoneum over the impinging finger (Fig. 3), and the point of the blades of the forceps is pushed down through the internal ring, hugging the anterior abdominal wall and in contact with the tip of the finger until it emerges from the mouth of the sac (Fig. 4). The suture in the mouth of the sac is drawn tightly around the blades of the Kelly forceps and the knot tied. The Kelly forceps is opened sufficiently to grasp the end of the tied suture and closed (Fig. 5). The forceps, grasping the end of the tied suture, is then withdrawn from the punctured opening in the transversalis fascia and peritoneum, drawing the sac through the opening, thereby inverting it. When the sac is thick and bulky the opening may have to be enlarged to permit this procedure. The inverted sac is then pulled outward with sufficient tension to eliminate any redundancy in the parietal peritoneum and thus to abolish the hernial fossa. The sac is transfixed and ligated, the excess distal to the ligature being excised (Fig. 6). The stump of the sac is then sutured to the edge of the opening of the transversalis fascia and peritoneum

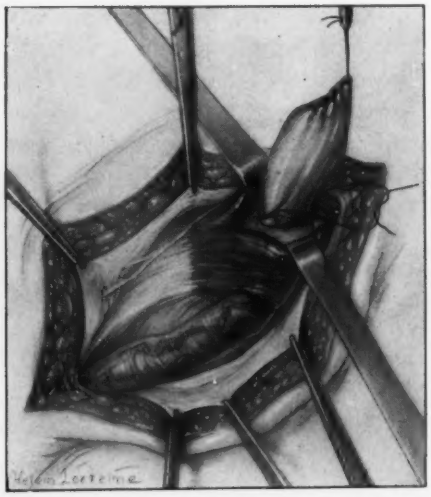

FIG. 6.—The sac having been inverted through the opening in transversalis fascia and peritoneum, is transfixed and ligated.

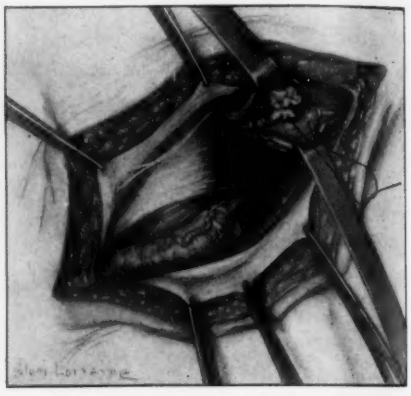

FIG. 7.—Sac is excised distal to the ligature and the stump is fixed to transversalis fascia and peritoneum with figure-of-eight suture.

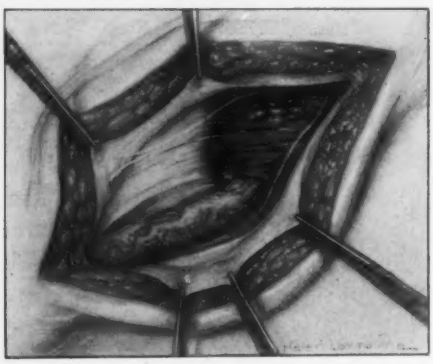

FIG. 8.—Separation in internal oblique over transversalis muscles is closed with several interrupted sutures.

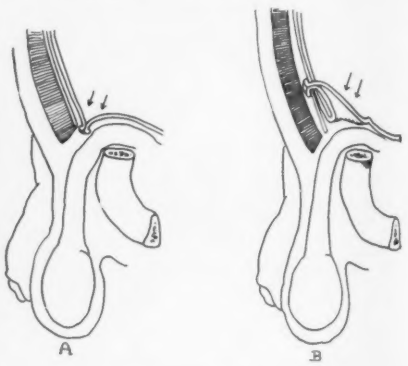

FIG. 9.—Diagrammatic representation of the appearance of a cross-section of the region at the internal abdominal ring. (A) When sac is ligated high in ring. (B) When sac is inverted.

with a figure-of-eight suture (Fig. 7). The opening in the oblique and transversalis muscles is closed with several interrupted sutures (Fig. 8). The inguinal canal is then repaired according to the desires of the surgeon.

CONCLUSIONS

This method of disposal removes the sac from the inguinal canal and places a barrier over the internal aspects of the internal ring. This can readily be demonstrated by passing the finger into the resulting peritoneal covered cone where the tense peritoneum can be felt holding the abdominal viscera well away from the inguinal region. It is simple of execution and adds perhaps five minutes to the operating time. It is not offered as a substitute for the Bassini technic, notwithstanding Kocher's results, but as a more effectual method of disposing of the sac. If employed in conjunction

with the modern methods of closing the inguinal canal, the rate of recurrence should be decreased.

This procedure has been employed in 66 cases, followed by the Bassini closure of the canal. To date, there have been no known recurrences. Many of these cases have been operated upon within recent months, and it is not possible, as yet, to evaluate the effects of this method of disposal of the sac, on the percentage of recurrence.

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Discussion.—Dr. Charles R. Robins (Richmond, Va.): It will always be difficult to bring out anything new. With reference to the illustration shown by Doctor Mastin, with the incision across the fibers of the internal oblique muscle, I found the same incision in a book by Bloodgood that I ob-

tained from a sale of Dr. Howard A. Kelly's library, which gave a résumé of all operations for hernia performed at Johns Hopkins Hospital up to 1894.

I am quite confident that the question of recurrent hernia will be settled in the Southern Surgical Association. We had a paper by Doctor Estes last year, in which he reported a low percentage of recurrences, and another member, Dr. Thomas M. Joyce, of Portland, Ore., published a remarkable series in the Journal of the American Medical Association.

I think some of the trouble we have in recurrent herniae is due to the incision. The real defect is over the pubic bone, and no incision is complete that does not expose the region of the pubic bone and the insertion of the rectus muscle. Doctor Mastin has been very fortunate in his cases because all his illustrations show a very fine conjoined tendon. One reason for recurrences is that there is no conjoined tendon. If you investigate your cases of inguinal hernia you will find this muscle to be deficient in direct hernia and very often in the indirect type.

The most important maneuver is to place the patient in the recumbent position and at ease. The finger is placed on the scrotum at a point which will permit its invagination. The finger is then passed along the cord up to the external ring. If the finger then can enter the abdomen in contact with the superior and posterior surface of the pubic bone the conjoined tendon is either absent or very poorly developed. Otherwise the finger could not enter the abdomen.

I would like to say that my approach to the hernia question, and my reason for discussing it at this time, is based on the fact that I am preparing a series of operations in which I have performed either the third or fourth operation for that particular hernia. This shows that whoever operated upon these cases before—the best surgeons in my section of the country—have left some hole that is not stopped up, and everyone knows that in direct hernia recurrences appear promptly.

The speaker here showed a series of slides illustrating the following conditions:

The first slide (Cunningham's Manual of Practical Anatomy) shows a normally developed conjoined tendon. It originates from the outer segment of Poupart's ligament and passes over the cord, and is inserted behind the cord in the iliopectineal line and the crest of the pubes. This contracts on the cord when there is increase in intra-abdominal pressure, as in coughing, straining, *etc.*, and produces the shutter action described by Sir Arthur Keith. It probably has a very important function in obliterating the processus vaginalis, the process of peritoneum which precedes the descent of the testicle.

The next slide shows the deficiency of the lower segment of the internal flat muscles, including absence of the conjoined tendon. The fibers pass directly over to the sheath of the rectus. In such a case a well developed sac of indirect hernia is often found in addition to the direct hernia.

A series of slides show a recurrent hernia with the sac of a direct hernia and also a femoral hernia. After the bifurcated sac (direct and femoral hernia) was removed, the finger could be introduced under Poupart's ligament through the femoral ring. The repair was effected by the fascial suture derived from the median pillar of the ring which attached the rectus muscle and sheath and the lower segment of the internal flat muscle, to the crest of the pubes, Gimbernat's ligament and Poupart's ligament. This effectively closed the muscular defect and also the femoral ring.

The last slide shows a young man, age 23, in whom there was muscle deficiency on both sides, a developed direct hernia on the left side, together with a well formed sac of indirect hernia, and on the right side a small

peritoneal sac projecting in the upper part of the cord together with the muscle deficiency, but with no protruding sac of either direct or indirect hernia. This case shows that the muscle deficiency is a congenital condition.

DR. WILLIAM F. REINHOFF (Baltimore, Md.): It has been indeed a pleasure to hear these three papers, as well as Doctor Robins' discussion. I wish to comment on the statement made by Doctor Mastin, that most of the recurrences in his series of cases operated upon for the cure of inguinal hernia have occurred at the upper angle of the wound. This is contrary to my experience and that of other members of the staff of Johns Hopkins Hospital. Apparently most recurrences in our cases have developed at the lower angle of the hernial wound. It is quite true that in Baltimore, as elsewhere, various technical procedures are employed. The obvious lack of unanimity of opinion in regard to operative treatment is based on the fact that in a certain number of patients, although this is a small percentage, the operation has failed to bring about a cure.

A most cursory review of the literature will reveal that each year articles on the operative treatment of this condition have been published, indicating that in spite of the fact that the majority of cases are now easily and permanently cured by a variety of procedures by the average operator, there is, nevertheless, a small but definite group in which recurrence is all too common.

It has been called to my attention, after dissection of more than 300 bodies during the course in surgical anatomy, in the last ten years, how infrequently one can demonstrate tendons which are described as normally occupying the lower inguinal region. For instance, in the cadaver in which no hernia exists, it is quite unusual to be able to demonstrate a conjoined tendon, and by conjoined tendon I mean the fusion of the transversus and internal oblique fascia lateral to the attachment of this fascia to the lateral edge of the rectus sheath. It is almost never possible to demonstrate a conjoined tendon due to fusion of the transverse and internal oblique aponeurosis as far lateral as the internal inguinal ring. It is more frequent, in the dissecting and operating rooms, to find the internal oblique muscle and its aponeurosis the more strongly developed of the two, and inserted separately on the ventral sheath of the rectus muscle. The falx inguinalis, in the absence of the conjoined tendon, is usually contributed to mainly by the aponeurosis of the internal oblique. The weakness or strength of the lower inguinal region is, therefore, in direct proportion to the strength of the aponeurosis of the internal oblique and transversus muscles between the internal inguinal ring and the lateral edge of the rectus sheath. If they are fused, the structure should be termed the conjoined tendon, which may be strong or attenuated in young or old, in the presence of or absence of hernia.

If the aponeurosis of the internal oblique and transversus muscles are not fused, the conjoined tendon is absent, but the sickle-shaped band of fibers in the accentuated aponeurosis of the internal oblique muscle, the falx inguinalis, may be, and usually is, present and definable. In adult cadavers and operative cases examined, the aponeurosis of the internal oblique and transversus muscles together, in the great majority of instances, have been found to be atrophic, indefinite and attenuated, rather than definite, strong and readily demonstrable. Thus, unless some technical method is devised to overcome this absence of fascia at the lower angle of the wound, the closure is bound to be insecure. This insecurity may be due to a paucity of tissue, as a result of which there is tension on the suture line which approximates the attenuated fascia of the transversus and internal oblique muscles to Poupart's ligament.

For these reasons, I wish to call attention to a simple procedure which not

only augments the fascia present in the lower inguinal region, but at the same time permits secure closure without producing the slightest tension, and thus remains true to one of the greatest and most fundamental surgical principles. This consists of a vertical incision made over the anterior sheath of the rectus and pyramidalis muscles down to their insertion in the pubic bone. The incision in the rectus sheath is carried down to the superior ramus of the pubic bone, and, superiorly, it may be continued as far as the reflection of the aponeurosis of the external oblique will permit. This incision releases the anterior rectus, and the enclosed muscle tends to bulge immediately. Lateral displacement of the rectus sheath is then accomplished easily, and the closure of the hernial wound is carried out in close accordance with the technic described by Halsted. This procedure is to be distinguished from the one originally suggested by Doctor Halsted, namely, turning over the flap of the rectus fascia as a door on a hinge, and suturing the cut end to Poupart's ligament; it will be noted in that procedure that there is a weak area at the lateral border of the rectus muscle. In the method I propose, the sheath is simply displaced and drawn laterally, so that the lateral edge of the muscle is not exposed and in time the anterior sheath grows back over the surface of the rectus muscle. In this way tension is avoided without the use of fascial strips. This procedure is to be especially recommended in operations for bilateral herniae.

Dr. Bradley L. Coley (New York, N. Y.): I should like to discuss the last three papers in a general way, without specific reference to any one of them. I believe we are all convinced that recurrences after hernia operations may be due to many factors, some of which are perhaps within our control, but many of which are not. Among the latter may be mentioned the surgical anatomy of the individual and the character of the tissues comprising the region through which the hernia escapes. Indirect inguinal hernia tends to recur either within the internal ring or at the lower angle just above the pubic bone. Recurrences at the internal ring may be due sometimes to an unnoticed indirect sac or an inadequately high ligation and excision. It is to prevent these recurrences that methods of disposal of the indirect sac, such as that described by Doctor Collins, have been devised.

Personally, I agree with Doctor Reinhoff that the majority of recurrences take place at the lower end of the canal. The reason here lies in a defect in the transversalis fascia and the high insertion of the internal oblique and transversus abdominis muscles to Poupart's ligament. To provide a bulwark for this undefended area (Hesselbach's triangle) is the aim of most operations for direct hernia, and it is to strengthen this area in particular, that Doctor Robins has worked out his operation. I believe that the rôle of the transversus muscle in effecting a firm repair in direct hernia has not been fully appreciated. The transversalis fascia is invariably thin and attenuated in cases of pronounced direct hernia. The transversus aponeurosis, however, is usually a fairly firm layer, and this can be sutured to Poupart's ligament as the first or deepest layer of the repair.

In the present crisis which confronts us, large numbers of men will be examined with a view to determining their fitness for serving with our armed forces. Many of these Selectees will be rejected because of so-called *potential hernia* or because of large inguinal rings. Those rejected will, as advised, seek operation for a cure of the so-called hernia. I can recall just after the First World War, while working under Dr. William A. Downes, that we encountered a goodly number of recurrent inguinal herniae in soldiers who had undergone operation for alleged herniae which had given them no symp-

toms and which were, in reality, large inguinal rings, or so-called impulses. These direct recurrences were often difficult to cure by further surgery; a number of them had successive recurrences and were never relieved. Therefore, I should like to make a plea for a more positive evidence of hernia before subjecting these borderline cases to operation.

DR. CHARLES GREEN (Houston, Texas): I think there are two important points in the repair of hernia. First, choice of anesthetic; and second, prevention of tension on the soft parts.

Several years ago I reported 315 cases of herniae before the Railway Section of the Southern Medical Association, with less than 2 per cent recurrences. I feel that this low percentage of recurrences was due, first, to the fact that the majority of the operations were performed under spinal anesthesia, thus avoiding the stage of excitement following operation, when the patient is reacting from a general anesthetic. I have seen patients waking up from a general anesthetic become so excited that it took two or three orderlies and nurses to keep them in bed, and only the Lord himself could keep them from tearing the repair of the hernia before regaining consciousness. This does not occur when spinal anesthesia is used. Local anesthesia is good, but because of the multiple punctures into the soft parts to produce local anesthesia there is more danger of postoperative infection than when spinal anesthesia is used. The second point is that we were very careful to see that no great amount of tension was produced when the hernia was repaired.

Personally, I do not feel that the best results can be accomplished in hernia repair without transplantation of the cord. In my hands the Bassini method of repair, with my modification of Bloodgood's modification and transplantation of the cord, is the best technic.

In closing, let me state that I cannot agree with Doctor Collins that the most frequent site of recurrence is the internal ring. My experience has been that recurrences are in the form of a direct hernia just over the pubic bone, at the most fixed point. However, Doctor Collins' technic certainly does away with any weakness at the internal ring.

DR. R. DUVAL JONES (Norfolk, Va.): In 1934, my associate, Dr. R. L. Payne, published, in the November issue of the Southern Medical Journal, a report of his results in the repair of 200 consecutive cases of inguinal hernia. With this report he published illustrations of a standardized technic which he had employed, using a strip of living fascia from the inner leaf of the external oblique aponeurosis for his main suture. His report was most gratifying and, since that time, we have built up our series to approximately 500 cases with continuous good results. We have had three known recurrences. The first recurrence was a direct result of the patient's falling down stairs while intoxicated, only three weeks after operation. The second, we attribute to a failure to close the defect sufficiently snug at its lower angle, and the third occurred in an elderly fat man as a result of infection around interrupted silk sutures which were used to reinforce the fascial suture.

I agree with Doctor Reinhoff and Doctor Robins that the two most common sites of recurrence are (1) where the neck of the sac opens into the peritoneum; and (2) the lower angle of the triangular space where it is often difficult to completely obliterate the defect. However, I am convinced that these weak points are satisfactorily overcome in the great majority of cases by carefully carrying out the technic which Doctor Payne and I have used in our series. This is simply a modification of Bassini's operation, utilizing a strip of living fascia from the inner leaf of the external oblique aponeurosis for the main suture.

The salient points in carrying out Doctor Payne's technic were here shown by the speaker by presenting several slides:

Slide I shows the point of the index finger in the external ring and the method of cutting out the fascial suture from the inner leaf of the external oblique aponeurosis which is left attached to the pubic bone.

Slide II shows the method of closing the neck of the sac at its highest point on a level with the parietal peritoneum after the sac has been dissected free and the contents have been reduced.

Slide III shows the fascial suture threaded on a large fascial needle and fixed with a single catgut tie. The suture is then placed under the cord and is used to approximate the conjoined tendon to Cooper's and Poupart's ligaments, thus closing the defect and providing a new bed for the cord. It is in the placing of the first stitch of this suture that one should be most careful to include Cooper's ligament, lest there be left a small opening through which recurrence may occur.

Slide IV shows the defect closed, a new floor having been made for the cord by suturing the conjoined tendon and arching fibers of the internal oblique to Poupart's and Cooper's ligaments, and fixation of the fascial suture with interrupted chromic catgut or silk sutures. Insert A shows the free end of the fascial strip being split; B shows the method of fixing the split ends with a square knot, and C shows the method of turning down the split ends after the square knot has been tied, and fixing them with chromic catgut or silk.

It has been a great privilege to hear these excellent papers and discussions on hernia, and I offer my discussion simply because I feel that, at least in the hands of Doctor Payne and myself, the technic I have attempted to describe has continued to give sufficiently good results to justify calling it to your attention.

Dr. Amos Koontz (Baltimore, Md.): I am sorry to prolong this discussion, but I would like to refer to what Doctor Coley has said about operating upon cases which have simply an enlarged ring. Fortunately, the Army regulations are definite on this point, and state that a diagnosis of hernia shall not be made on the basis of an enlarged ring and slight impulse alone. The diagnosis is to be made only if a sac is demonstrable. In the early days of selective service examinations some of our best surgeons turned down men who should not have been rejected. These doctors were working as civilian employees at army examination stations, and we had a tough time educating them to the point where they did not reject men improperly. Many men with enlarged rings and slight impulses go through their whole lives with this condition and never develop a hernia. I agree with Doctor Coley that operating upon such cases, especially under war conditions, may make hernia cases out of some of them.

With reference to Doctor Cannaday's paper on cutis graft, although I have had no experience with such grafts, there is evidence for believing that what he says about the ultimate fate of the graft is correct. In experimental work which I did some years ago, I showed that when a piece of the rectus sheath is removed it regenerates in a very short time, and very often the regenerated sheath is stronger than the original fascia. In the case of the cutis graft, I expect that the ingrowth of fibrous tissue from the surrounding rectus sheath eventually makes the graft stronger than it was at the time of implantation. It seems to me, however, that there are two objections to the operation. The first is the removal of a large piece of skin from some other part of the patient's anatomy. In the second place, one would think that the flimsy nature of the cutis graft would make it unsuitable to resist

the impact of the intra-abdominal pressure. In these cases I am still using large sheets of preserved ox fascia, as described in the Archives of Surgery, in March, 1933. In using preserved fascia there is one thing that must be remembered. It is preserved in a chemical solution which is irritating to the tissues and, therefore, the fascia should be thoroughly washed in salt solution prior to its use. At one time the firm that puts out ox fascia changed the preserving solution, and started to put it up in a very irritating solution which caused sterile abscesses. This caused the material to get a very bad name, which it certainly deserved as put up in that particular preserving fluid. However, as soon as this was brought to my attention the obnoxious fluid was quickly eliminated and the material is now put up in a solution of 1 per cent biniodide of mercury in alcohol. The present material is very satisfactory and is used with excellent results by a great many surgeons. Doctor Stone recently told me that in his operation for anal incontinence he can see no difference in the results between preserved ox fascia and autogenous fascia. Dr. Henry Cave of New York has the fascia soaked in salt solution for two hours before using it. It is my practice to have the nurse, as soon as she is scrubbed up, break the tubes of fascia, thoroughly wash them in salt solution and then put them in a second basin of salt solution to soak until they are used.

I was much interested in Doctor Collins' method of dealing with the hernia sac, and believe that his method presents a simplified procedure for carrying out LaRoque's principle.

With regard to Doctor Mastin's paper, I thoroughly subscribe to the principle of subcutaneous transplantation of the cord, which was the essential part of the original Halsted operation. There seems to be a definite trend back to this procedure. It seems to me to have two distinct advantages. In the first place, it allows very tight closure of the lower end of the suture line, which is the point at which most herniae recur. In the second place, the subcutaneous transplantation has the advantage over transplanting it between any of the other layers, in that it allows the muscle and the two layers of the imbricated aponeurosis of the external oblique to grow together in a solid sheath which, it seems to me, presents a much stronger bulwark against intra-abdominal pressure than if any of these layers are separated by having the cord between them.

Dr. John E. Cannaday (Charleston, W. Va., closing): With reference to the subject of inguinal hernia, our results have been considerably improved since we began using single, interrupted cotton thread sutures. In regard to the use of the cutis graft, for certain large herniae, which used to be considered inoperable, it is by far the most satisfactory method I know of.

Dr. Joseph D. Collins (Portsmouth, Va., closing): The procedure I have suggested does not entirely solve the recurrence problem. However, I believe it will serve as a first line of defense against recurrence. It is particularly applicable where the neck of the sac is of such width that it is impossible to ligate it above the internal ring.

As Doctor Green has stated, when a patient reacts from a general anesthetic in a state of delirium there is always a danger that the plastic repair of the canal may be damaged. This damage may be the inception of a recurrence. By using this method of disposal of the sac, the abdominal viscera will be held away from the suture line until firm union between the conjoined tendon and Poupart's ligament has taken place.

Dr. E. V. Mastin (St. Louis, Mo., closing): I feel sure that Doctor Robins must have misunderstood me, as I did not intend to give the im-

pression that recurrences do not occur at the lower end of the wound, for I am certain that the greater number of recurrences do occur there. So much attention has been paid to this fact that many surgeons have adopted a technic of transplanting the cord directly under the superficial fascia, thereby completely closing the lower angle with the falx inguinalis and two layers of the aponeurosis of the external oblique muscles, thus making such a strong closure that recurrences seldom occur at this point. With the lower angle taken care of, the other point of weakness I have encountered has been around the cord, and the technic I have described has minimized this. Formerly I had some difficulty with swelling of the testicle due to trying to close the fascia around the cord too tightly, but since cutting the internal oblique muscle and changing the position of the cord, I have had no difficulty with this swelling, and have not found it necessary to use a scrotal support for more than a year. In cases where the falx inguinalis was not sufficiently strong to give adequate protection at the medial angle of the incision, I have made a practice of cutting a portion of the rectus sheath and bringing it down with the falx inguinalis to strengthen this defect, but this has only been necessary in a relatively small number of cases.

THE USE OF THE CUTIS GRAFT IN THE REPAIR OF CERTAIN TYPES OF INCISIONAL HERNIAE AND OTHER CONDITIONS*

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BY THE TERM "cutis graft" or "dermal graft" as used in this paper, is meant an excised area of skin, usually with an underlying layer of fat, from which the epidermal layer has been removed and which has been implanted into the body tissues. Otto Loewe,[1] of St. Marks Hospital, Frankfort-on-Main, apparently first made use of the cutis graft. In 1913, he reported his results in nine cases. In 1929, he reported on his use of cutis grafts in about 100 patients, including all types of cases in which fascia had hitherto been used, including such operations as replacement of damaged dura, repair of large incisional herniae, fractures of the long bones, arthroplasties of the knee, hip and elbow joints, and habitual dislocation of the shoulder joint; he employed cutis material in the form of sutures and ligatures, also for suspension or fixation with generally good results.[2] He observed that these grafts heal in place and become firmly attached even under unfavorable conditions.

Rehn[3] published his first report of cases in 1914. Later in his monograph on the use of cutis transplants he described two reconstruction operations performed by him in the fall of 1913, in which destroyed portions of hand tendons were replaced with strips of cutis. He began using cutis grafts in connection with various reconstructive operations in which fascia had hitherto been used. Rehn[4] believed that cutis was the most suitable material for repairing certain defects because it best answered the requirements for tissue regeneration as outlined by Roux.[5] He believed that the tension under which the graft had been sewn in place acted as a stimulus to the bringing about of a gradual metaplasia of the transplant.

Uihlein,[6] who checked over a total number of 104 case records of patients operated upon by Rehn since 1928, in the University Clinic at Freiburg, noted 15 wound infections; of these the results in nine were good, six not satisfactory. Four patients died from pneumonia. Of the total number there were 65 incisional herniae, 11 inguinal herniae, eight knee joints with lateral motion, 20 miscellaneous. The late results in 70 were good; in 14 poor; results unknown, 20 cases.

Eitner,[7] during World War I, made extensive use of transplants of skin, fat and fascia, separately or in combinations, as free or attached transplantations in the course of plastic operations. He reported on this work in 1920, and stated that the results with the use of derma were more permanent than when other material was used.

The subject of cutis grafting has been discussed in some detail by Maingot,[8] also by Fomon.[9] Davis,[10] Byars,[11] and his associates, likewise Bames,[12] Straatsma,[13] Smith,[14] and Peer,[15] all have made use of dermal grafts for filling out defects, particularly in the region of the face and head, and have

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9, 1941.

found them satisfactory. In this type of surgery at times more than one thickness of dermal tissue is used.

Experimental Work.—Rehn,[16] and Schwartz,[17] in operations upon dogs, removed a portion of the Achilles tendon and closed the defect with a cutis graft. In ten weeks the repaired tendon, functionally and structurally, closely resembled the control tendon on the opposite side.

Eitel,[18] by means of Warburg's method for estimating tissue metabolism, showed that the metabolic rate of derma was considerably higher than that of fascia. Work done by Davis and Traut,[19] Carnot and Deflandre,[20] and Barker,[21] in regard to burying full-thickness skin, showed the feasibility of securing satisfactory "takes" after practically all such implantations. Peer and Paddock[22] had histologic sections of human derma made at intervals of from a week or ten days up to a year or longer after implantation. They found, in most instances at least, that even though a careful attempt was made to remove all the epidermis from the graft prior to its implantation, some epidermal tissue was left, that the sebaceous glands and hair follicles disappear early, that the sweat glands disappear later and undergo gradual transformation into fibrous tissue, that the derma survives by fusion with the adjacent subcutaneous tissue, and that this is brought about by the mechanism of inflammation and repair associated with aseptic wound healing.

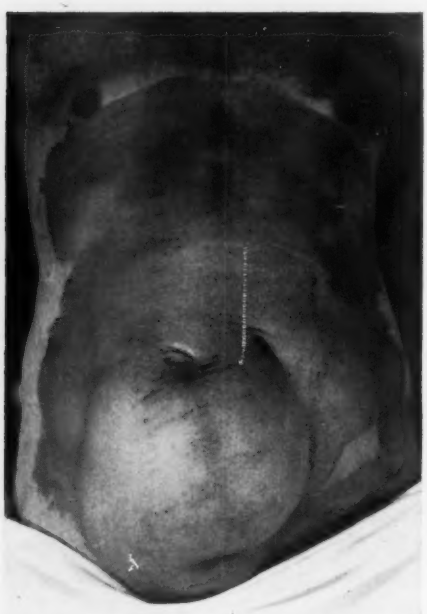

FIG. 1.—Hernia prior to operation, anterior view.

Advantages.—Cutis is better suited for plastic repair than fascia because it is more active and has longer life. It makes a repair that is stronger and more resistant to the impact of pressure or strain. Cutis is more readily available. According to the laws of the mechanism of development derma could be expected to undergo a type of transformation according to its use. Cutis takes readily and heals in place firmly in a comparatively short time.

Operative Technic.—The operative procedure is essentially the same as that used for the implantation of fascia. After making as thorough a closure of the hernial opening as possible by the usual surgical methods, the epithelium is removed from a suitable area of skin, preferably situated on the antero-external aspect of the upper third of the thigh. However, cutis from the skin covering the hernia or other areas will be found almost as satisfactory. This cutis is cut into a suitable shape so as to overlap moderately the fascial edges surrounding the hernial opening. A thin layer of fat, usually about

2.5 mm. in thickness, is left underneath the graft. The graft is placed and sutured under firm tension with Nos. 30 or 40 (usually the latter) interrupted cotton thread sutures spaced at frequent intervals. By the use of a double graft, that is, by suturing one graft either to the peritoneum and posterior fascia or to the undersurface of the aponeurosis and the other on top of the aponeurosis, we ensure a much stronger abdominal wall. Sulfanilamide crystals and sulfathiazole in small amounts (usually not more than 2 Gm. of each) are placed between the different layers of tissue. The subcutaneous tissue is

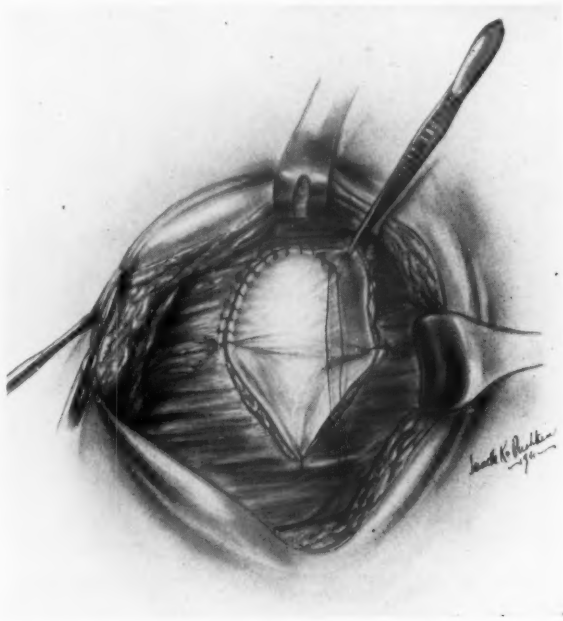

FIG. 2.—Cutis graft being sutured to rectus aponeurosis.

sutured over the graft with cotton thread sutures Nos. 60 or 70. No tension sutures are used in the wound closure. Skin clips are used in closing the skin edges, and No. 70 cotton thread sutures are placed between the clips, each suture taking a very small bite of skin.

It has been advised by Rehn,[23] and some other German surgeons, that hernia cases in which cutis implants have been used, be kept in bed from six to ten weeks with a view to waiting until the transplant had been to a considerable extent converted into fibrous tissue. My observations lead me to believe that the skin implant is very firmly united as early as three weeks subsequent to implantation, and that prolonged rest in bed is not necessary.

In the formation of replacements for damaged tendon the cutis tissue may be used either in a single strip or strips braided or twisted together; in the replacement of large tendons such as the tendo achillis, a flat strip of skin with the edges sutured together as a tube with the fat side out.

The indications for the use of cutis are essentially the same as those for

FIG. 4.—Cutis graft repair of large direct inguinal hernia.

FIG. 3.—Hernia ten weeks after operation.

the use of fascia or tendon; cases of large incisional herniae in which the edges of the aponeurosis cannot be made to overlap; inguinal herniae in which the structures surrounding the opening are defective or those in which the structures about the ring cannot be approximated without undue tension, tissue replacement after excision of the patella; the reconstruction of unstable knee and elbow joints by using grafts to replace or to supplement weak or absent external ligaments; habitual dislocation of the shoulder, also lower jaw; the filling out of depressions due to the loss or absence of tissue; the replacement of portions of tendon that have been destroyed; the use of strips of cutis for suture material; suturing the ends of fractured bones together, securing bone grafts in place; the anchoring of either end of the dislocated clavicle; arthroplasties of elbow, knee and hip joints.

FIG. 5.—Cutis graft in place showing incisions for insertion in case of slipping knee. Translation (German terms) *Kutislappen*—Skin flap. *Kutisplastik bei*—Cutis plastic for. *Schlotterknie*—Side slipping or wobbling knee. (After Rehn. Arch. of Surg., **38**, No. 1, 127, January, 1939. Article by Alfred Uihlein, Jr.)

We have used cutis grafts in the repair of six large incisional hernias (in one of these a double thickness graft was used), five large indirect inguinal hernias with defective structures (two of these by Dr. Bankhead Banks, one by Dr. Hugh A. Bailey, both surgical associates), one repair of double fracture of the patella, one on-lay bone graft for ununited fracture of ulna, one suspension of the uterus, all with primary healing and apparently satisfactory results.

ILLUSTRATIVE CASE REPORTS

Case 1.—B. P., white, male, age 51, admitted to the hospital May 27, 1940 with a very large epigastric hernia. The bulge on deep expiration was fully 4½ inches across. He had a small ulcerated area over the hernia. A wire screen was placed over this and the patient was kept in the hospital for 3 weeks at the end of which time healing had taken place.

Operation.—July 9: The hernial sac was excised, parietal peritoneum was closed by overlapping. The edges of the muscular aponeurosis could not be approximated. A cutis graft from the thigh was sutured over the defect. The patient had an uneventful con-

valescence. A recent check shows no evidence of recurrence. He returned to his former occupation of coal loading several months ago.

Case 2.—T. L. K., white, male, age 69, admitted to the hospital April 19, 1941 for repair of a large lower right incisional abdominal hernia. Weight 170 pounds. Blood pressure 170 systolic, 110 diastolic. The size of the hernial bulge was approximately that of an average baby's head.

Operation.—May 8, 1941: The hernial sac contained several loops of small bowel. The opening in the aponeurosis was approximately 4 x 2 inches wide. This was closed by use of a cutis graft from patient's thigh. He made a satisfactory recovery with no evidence of recurrence to date.

Case 3.—H. T., white, male, age 23, was admitted to the hospital, December 21, 1941, with two transverse fractures of the patella, and a nearly complete transverse laceration of the patellar aponeuroses, also, a considerable laceration of the skin over the patella.

Operation.—January 5, 1942: Open reduction of the fracture was effected, together with repair of the aponeuroses over the patella by a cutis graft-suture taken from the skin of the thigh just above the knee. This was carried through the aponeuroses from one side to the other, twice on each side, and anchored at various points with interrupted sutures. The wound healed normally. A plaster encasement, with walking-iron, was applied. He was discharged January 18, 1942.

Case 4.—J. H. E., white, male, age 58, was admitted to the hospital, December 30, 1941, with a very extensive incisional hernia in the right upper abdomen, following a gallbladder operation two years previously. There were five separate pockets in the hernial area.

Operation.—January 8, 1942: Two cutis grafts were used. The first was taken from the redundant tissue in one of the wound flaps and was sutured to the posterior fascia and parietal peritoneum. The remains of the fascia were sutured over this graft. A second cutis graft, from the right thigh, was sutured to the aponeurosis surrounding the hernial opening. The patient was discharged January 16, 1942.

Case 5.—I. T., white, male, age 54, was admitted to the hospital, January 7, 1942, for repair of a large, right direct inguinal hernia.

Operation.—January 9, 1942: After the sac had been closed and the transversalis fascia sutured, a cutis graft was placed in position and sutured to the shelving edge of Poupart's ligament laterally; to the pubic periosteum at the lower end; on the medial side to the sheath of the rectus in the lower two-thirds and to the conjoined tendon in the upper third; a small notch was cut in the graft so as to make it fit loosely around the cord. The aponeurosis of the external oblique was brought underneath the cord, and the undersurface of the aponeurosis was sutured to Poupart's ligament so that it would fit snugly over the cutis graft.

CONCLUSIONS

Cutis may be used in all cases in which the use of fascia or tendon might be indicated, with the expectation of better results. It heals in rapidly and well; has great vitality; is able to survive under adverse conditions; possesses great tensile strength; has a good blood supply; gradually assumes the function of the part it replaces; and is readily available.

Its greatest value lies in the repair of large incisional herniae, also inguinal herniae with defective structures or those in which the structures cannot be brought into proper approximation without undue tension. It is useful in bone and joint surgery; is suitable for the reconstruction of tendons; makes

excellent ligature and suture material; and is of value in filling out defects of contour in various parts of the body.

NOTE: The writer wishes to acknowledge the help and assistance of Dr. Bankhead Banks and the hospital resident staff in the development of this method and in the care of these patients.

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RETROVAGINAL HERNIA *

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Retrovaginal hernia and other defects in which there are changes in the normal anatomy and relationships of the pelvic floor and the cul-de-sac of Douglas have been discussed in the literature under the titles of posterior vaginal hernia, enterocele, cul-de-sac hernia, Douglas' pouch hernia, and high rectocele. Some of these conditions are not true herniae, and, therefore, the term retrovaginal hernia, applied to a definite entity which meets the requirements of a true hernia, seems appropriate and descriptive of the condition under discussion. Anatomically, it is characterized by the protrusion of a peritoneal sac through the cul-de-sac of Douglas which dissects its way between the vagina and the rectum and presents as a mass in the vagina. It is of rare occurrence.

This seems strange when one stops to consider the anatomy of the pelvic floor, which is composed largely of the levator and coccygeus muscles and their covering fasciae.

In animals who travel on all fours, the force of intra-abdominal pressure is exerted on the abdominal muscles, and the levator and coccygeus, or their comparable muscles, have the function of moving the animal's tail. In the human, the erect posture transfers to them the function of a pelvic floor.

This diaphragm is perforated by openings for vessels and nerves, and by larger openings for the urethra, vagina and rectum.

The superficial fascia of the pelvic floor extends onto, and is intimately connected with the urethra, vagina and rectum.

Derry[3] has pointed out the fact that the levator is one of the most variable muscles in the body. Symington[2] states that the center of the pelvic floor averages one inch in thickness, whereas laterally it may attain a thickness of two or three inches. He thinks the vaginal opening is the main source of weakness but this is offset to some degree by the fact that the vagina passes obliquely from below upward and backward so that the general effect of intra-abdominal pressure is to force the anterior wall against the posterior.

Although this diaphragm is perforated at its thinnest portion in the midline by three large tubular structures whose lumina vary in size to accommodate the passage of material, hernia in this area rarely occurs.

The obliquity of the pelvic cavity which allows the force of intra-abdominal pressure to expend itself to some extent on the bladder, symphysis and anterior abdominal wall no doubt furnishes considerable protection to the pelvic floor.

The length of the mesentery of the intestine and the frequent presence of the sigmoid flexure occupying the cul-de-sac probably act to some degree in protecting the pelvic floor from intra-abdominal pressure in the absence of fluid or tumors.

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

While most of the reported cases of retrovaginal hernia have occurred in women who have borne children, cases have also occurred in nulliparous women.

The strain and trauma of childbirth thus assume considerable importance in the etiology, but some congenital defect must play an important part since the condition is so rare in multiparous women and occurs in those who have not borne children. Such a defect may occur in the muscular diaphragm or the fascia.

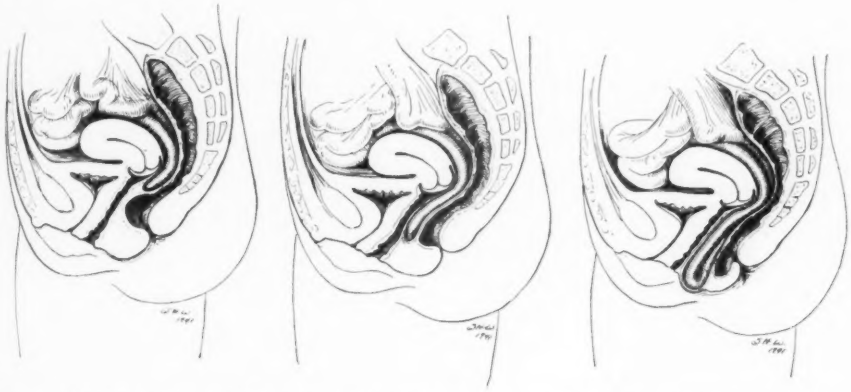

FIG. 1.—Varying degrees of herniation. This condition may occur with or without an associated rectocele.

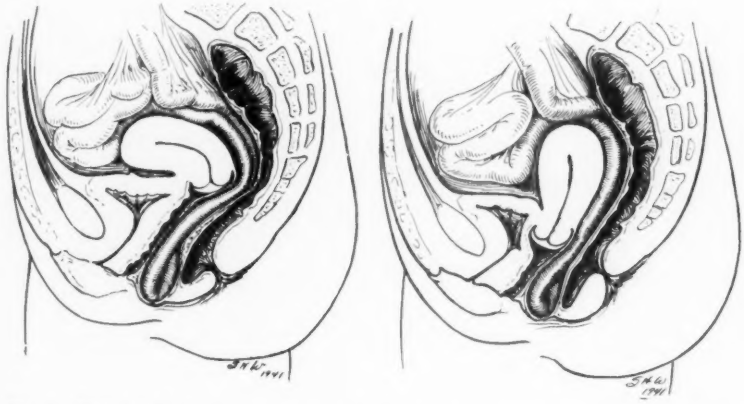

FIG. 2.—Postvaginal hernia may occur with the uterus in normal position or associated with varying degrees of prolapse.

It is probably true, however, that even in the presence of such a defect a congenitally deep cul-de-sac is an important factor in the development of such a hernia.

In the fetus, Douglas' pouch extends down to the levator muscles. It is gradually elevated during development until, at puberty, it is opposite the second or third sacral vertebra. If this elevation does not take place a congenitally deep cul-de-sac results.

Blaisdell[16] has described ligamentous bands originating on each side of the cervix at the insertion of the uterosacral ligaments, which extend downward and are attached to the vaginal vault. He calls them *ligamenta plica vaginalia*. They give support to the vaginal vault, and if congenitally absent or if injured during childbirth they allow the vaginal vault to sag and contribute to the formation of a deep cul-de-sac. Under such circumstances, should there be a defect in the muscles or fascia of the pelvic floor, conditions are present which predispose to retrovaginal hernia.

The strain and trauma incident to parturition, increased intra-abdominal pressure from fluid or tumors in the abdomen, or prolonged severe muscular effort might be the initiating factor in the formation of such a hernia.

There is a marked degree of confusion evident in the literature as to what properly constitutes a true retrovaginal hernia.

Hall,[4] in summarizing a review of the literature on this subject, comments as follows: "Today there are complete disorganization in the literature and a lack of reliable statistical data on vaginal and pelvic herniae because of multiplicity and uncertainty in terminology and diagnostic requirements, and because of inadequate examinations and reports: and mistaken interpretations to be noted in many writings."

Miles[5] has noted this confusion and has proposed that all herniae through the pelvic floor should be classed as pelvic hernia with the point of egress denoted to give the subvariety of the hernia.

This follows the common usage with reference to hernia into the inguinal canal, where the terms direct and indirect denote the point of egress of the hernia from the abdominal cavity. Adoption of this suggestion would greatly simplify the problem of pelvic hernia.

Miles pointed out that cystocele and rectocele are spoken of as herniae, while neither meet the requirements of a peritoneal sac. They are merely prolapses of the anterior or posterior vaginal wall.

With reference to prolapse, he has the following to say: "In descensus or prolapse of the uterus accompanied by abdominal viscera bulging into the cul-de-sac, there is no true hernial sac and no ring or aperture through which the viscera herniate. The uterus descends because of stretched and attenuated cardinal and uterosacral ligaments. The cul-de-sac is enlarged and there is a descent of the pelvic floor. This condition is properly called elytrocele or vaginal enterocele."

Cary and Young[6] agree with this viewpoint and state that: "A true posterior vaginal hernia is a definite peritoneal sac pushing down from the pouch of Douglas in the midline and dissecting between the rectum and vagina. The neck of the sac is located between the uterosacral ligaments just behind the top of the vagina, and through this abdominal contents pass to form a mass which may bulge out through the vulva when the patient strains down."

Sweetser[7] reports a case in which he opened the abdomen, and presents a drawing showing an opening posterior to the uterus in the center of the

pouch of Douglas. He says this was one inch in diameter and that the finger could be passed through the opening into the pouch below.

Black[11] also has reported a case in which the neck of the sac only admitted the index finger.

The importance of the deep cul-de-sac in relation to prolapse of the uterus has been emphasized by Jones,[8] Potthast,[9] and others.

It is recognized that many of the failures following vaginal hysterectomy have been due to neglect in obliterating a deep cul-de-sac, and this step in the operation is now generally practiced. Ward[13] and Counseller[14] have both emphasized its importance.

FIG. 3.—Examination with one finger in the vagina and one in the rectum is of the greatest diagnostic value in differentiating this condition from rectocele.

Here, there is a downward pouching of the relaxed cul-de-sac which pushes the upper part of the vagina ahead of it, but there is no true sac dissecting its way between the rectum and vagina. Such a cul-de-sac fails to qualify as a retrovaginal hernia.

Prolapse of the uterus with sagging of the pelvic floor and a wide, deep cul-de-sac may be compared to marked diastasis of the recti muscles. In this condition, there is a pouching of the abdominal wall lined by peritoneum, but no true neck or sac in the sense these terms are used in relation to other herniae.

If Miles' criteria as to what constitutes a true retrovaginal hernia are accepted, a great many cases reported as such will have to be rejected.

Hall[4] accepts only 26 reported cases as fulfilling the requirements, while Cary and Young[6] say that there are 70 authentic cases on record. No doubt there are many unreported cases.

The symptoms complained of by the patient are a sense of weight and pressure in the pelvis, and a variable degree of bulging into the vagina. Where the sac is well developed, a mass may protrude from the vagina on standing or straining, which usually disappears when the patient lies down.

Many of the reported cases had had previous operations for suspension of the uterus, or for plastic repair of the pelvic floor, with a recurrence of the bulging as soon as the patient got up. This is always suggestive of such a hernia.

Cases are on record where several plastic operations have been undertaken, with immediate return of the protrusion, and only when the true condition was discovered and treated was relief obtained. In these cases the rectocele had been cured but the hernia was unrecognized and promptly protruded after operation.

When a woman presents herself complaining of a vaginal protrusion, it is natural to think of the common causes of this condition, namely, cystocele, rectocele, or prolapsus. Unless vaginal hernia is borne in mind, and a search made for it, it may be overlooked.

If the mass contains intestine, peristaltic waves may be seen over its surface, and reduction may be accompanied by a gurgling sound. This is not present if the contents are omentum or fluid.

Examination with one finger in the rectum and one in the vagina will differentiate the condition from rectocele, which may coexist, as it will show that all the protrusion is not due to the rectocele. In cases where rectocele does not exist this maneuver helps to establish the fact that the protrusion originates behind the cervix, and if the patient is asked to strain it will determine the presence of abdominal contents in the protrusion.

The following complications have been discovered by Bueerman[1] in his survey of the literature (Table I).

TABLE I

Complications	No. of Cases
(A) Interference with delivery	10
(B) Hernia incised or excised because of error in diagnosis, with death	3
(C) Pelvic abscess following delivery with spontaneous cure	2
(D) Rupture of hernia with evisceration and death	2
(E) Rupture of hernia with recovery	1
(F) Rupture of hernia during delivery with recovery	1
(G) Death from incarceration of hernia	1

In view of the small number of cases accepted by Bueerman as proven in his review, namely, 76, these figures prove the condition to be serious and accompanied by a rather high mortality.

The treatment is surgical. Palliation by pessaries does not afford relief as it does in some cases of prolapse, since a pessary cannot obstruct the hernial opening.

The same principles apply here that apply to the treatment of hernia elsewhere, namely, isolation of the sac, disposition of the sac, and closure of the point of egress of the hernia from the abdominal cavity.

There are two avenues of approach. The abdomen may be opened, the sac

inverted into the abdomen and disposed of, and the cul-de-sac obliterated by the Moschcowitz technic for the treatment of prolapse of the rectum. An abdominal approach may be necessary if abdominal contents are adherent in the sac, or if intra-abdominal pathology requires section.

In cases where this is not necessary, the vaginal approach is more desirable. This consists in opening the vaginal plate from the perineum to the cervix, dissection of the sac from the rectum and surrounding tissues, ligation of the neck of the sac, excision of the excess, anchoring the stump behind the cervix, and obliteration of the cul-de-sac by approximating the uterosacral ligaments. The remaining tissues are approximated and a high perineorrhaphy completes the operation. An occasional case may require both the vaginal and abdominal approach.

The following case seems to meet the requirements of a true retrovaginal hernia:

FIG. 4.—Appearance of the mass in the case reported, when the patient strained.

Case Report.—Mrs. J. J. U., white, age 52, housewife, para 4, gravida 5, was seen April 14, 1941. *Chief Complaint:* Vaginal protrusion and soreness in lower abdomen. *Previous History:* In September 1938, she had been operated upon for prolapse of the uterus by the Murphy technic. Following the operation she had soreness and pain in her lower abdomen and pelvis. The pain was at times sharp and cutting in character, and at other times dull, with a feeling that everything was dropping out of her. In April, 1939, she discovered something protruding from her vagina. This mass had become irritated and there had been a discharge purulent in character, at times streaked with blood.

The mass now protrudes from the vagina, becomes very sore, and causes her to curtail her activities, keeping her in bed a good deal of the time. When she lies down the mass recedes, and she is more comfortable. She takes enemata frequently. If she does not she says it feels as if the bowel gets into the protrusion and makes her uncomfortable. At times she has burning on urination and a feeling as if she had not emptied her bladder completely.

Physical Examination.—Abdomen: Transverse lower abdominal scar under which can be felt a tender mass, probably the halves of the uterus implanted in the abdominal wall.

Pelvic: Parous outlet. Small cystocele, redundant vaginal walls. When the patient was asked to strain, a mass as large as an orange appeared through the vulva with startling suddenness. This could be easily reduced, and was accompanied by a gurgling sound. With a finger in the rectum and one in the vagina it was apparent that the patient had only a moderate rectocele and that the mass was a hernia containing intestine. The cervix was fixed high up in the vaginal vault.

Operation.—An incision was made from the cervix to the middle of the perineum, after normal salt solution with adrenalin had been injected under the vaginal plate. The rectum was identified by passing a sponge stick with tonsil sponge into the rectum.

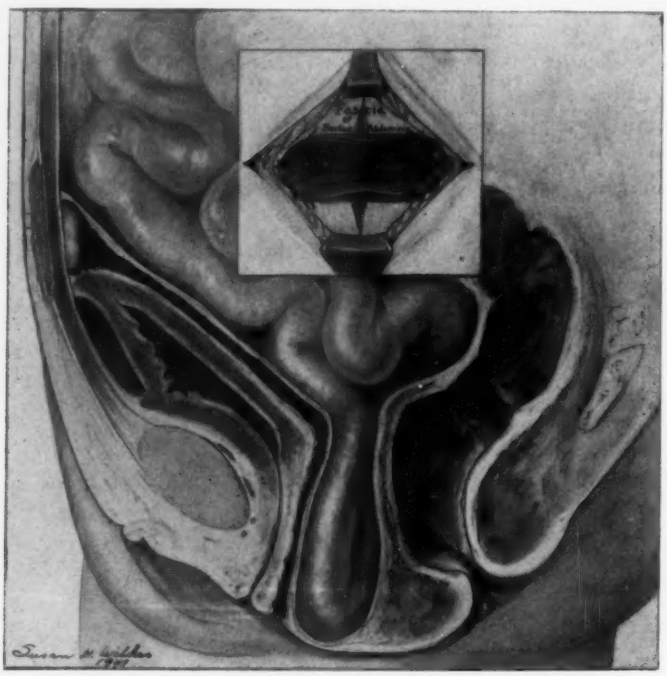

FIG. 5.—Condition present in the case reported. Inset shows the uterus sutured to the abdominal fascia according to the Murphy technic.

The peritoneal sac was dissected loose from the rectum, and freed entirely from the vaginal plate and dissected up to the level of the ureterosacral ligaments at the cervix. The sac was opened and a small amount of straw-colored fluid escaped. This was evidently a pocket which had been shut off. Another opening was made which entered the peritoneal cavity, and small intestine appeared in the wound. The table was raised to a Trendelenburg position and the intestine pushed back into the cavity.

The sac was ligated by a purse-string suture inside, and then by a suture outside of this suture, and the excess sac was cut off. The stump of the sac was sutured to the posterior surface of the cervix. The patient had had a previous suspension operation and it was impossible to pull the uterus down enough to identify the ureterosacral ligaments, but the tissues behind the cervix were brought together by interrupted sutures in an effort to obliterate the cul-de-sac. A line of sutures was then placed approximating the fascia over the rectum. The excess of the vagina was cut off, a high perineorrhaphy was performed, and the vaginal plate closed by interrupted chromic catgut sutures.

A recent examination of the patient shows that there has been no recurrence and that she has been relieved.

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ACUTE HEMATOGENOUS OSTEOMYELITIS*

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THE ADVENT of chemotherapy and revival of attempts to control severe staphylococcal infections by serum therapy have been partially responsible for renewed interest in the study of acute hematogenous osteomyelitis. Perhaps the greatest single impetus were reports suggesting that the long accepted teaching that the one great measure in the relief of the disease, to drill the bone and release the infection, was not only not helpful but actually harmful. While this question has remained undecided, numerous new advantageous measures have been introduced and added to our therapeutic armamentarium.

In this communication, a series of cases of acute hematogenous osteomyelitis are reported. The details of a group of 66 cases of the disease occurring at Charity Hospital, New Orleans, from 1937 through 1940, are given, and are compared with a series of 112 cases previously reported by one of us[1] from the same institution. The mortality for the more recent group was 6.6 per cent, and the mortality for the previous group of 112 cases occurring in the same institution between 1930 and 1936, inclusive, was 24.1 per cent. This great discrepancy in mortality represents an obvious improvement in management of the disease, and it was hoped by a detailed study of the two groups and comparison of their divergent methods of management that some facts could be culled which would help to establish the correct changes in therapy.

In studying these cases an attempt was made to review the records of only primary cases of acute hematogenous osteomyelitis. By this is meant cases which were not operated upon elsewhere and cases not in a chronic stage. They were considered primary acute hematogenous osteomyelitis even though the disease had been present for two weeks, provided the symptoms were acute and they had not been operated upon. Only hematogenous osteomyelitis was included. Traumatic osteomyelitis resulting from compound fractures and osteomyelitis by continuity from some local infection was excluded. In addition to this, recurrent cases of acute hematogenous osteomyelitis were excluded even though the disease had apparently healed and recurred locally.

Osteomyelitis is common, but acute hematogenous osteomyelitis, restricted to primary cases, may be found surprisingly uncommon, even rare. The impression that it is more common than it is probably comes from the fact that recurrences are so numerous and that reported series usually contain these recurrences.

* Read before the Southern Surgical Association, at Pinehurst, N. C., December 9–11, 1941.

Even in a large institution like Charity Hospital in New Orleans, where from 1937 to 1940 there were 237,105 patients actually admitted to the hospital beds, only 66 cases of primary acute hematogenous osteomyelitis were found. This represents one patient with acute hematogenous osteomyelitis in every 3,592 patients. In the previous series from the same institution, the incidence was one case in 3,490 patients admitted.

Negro children have the disease relatively less frequently than white children. Fifty-one (77.3 per cent) of the 66 cases in this second series were white patients and in the same period, approximately 55 per cent of the total admissions were white patients. A similar variation in the incidence of osteomyelitis in Negro and white patients was reported in the previous series.[1] A possible cause for this difference is the greater susceptibility of the white race to skin infection and thus staphylococcal infections in general. This is a casual observation for which we have no conclusive proof. Boils, frequently seen in white patients, are relatively rare in the Negro race. Fourteen (21.4 per cent) of the 66 patients in this group gave a history of boils either immediately before or concomitant with the onset of acute hematogenous osteomyelitis. All of these 14 patients were white patients.

The more frequent occurrence of the disease in the male is again shown in this study. Forty-four of the patients were males and 22 were females. The explanation for this greater susceptibility in boys has repeatedly been stated to be the trauma factor. Possibly, also, there is variable incidence of dermal infection in the two sexes.

Trauma was mentioned as a casual factor in the records of 24 cases (36.4 per cent), probably too high a figure to be merely a coincidence. The disease with its prolonged morbidity is so severe, that it would not seem incorrect to recommend partial inactivity for children with furunculosis, if only to avoid such a serious even though unlikely complication as osteomyelitis.

Acute hematogenous osteomyelitis is predominantly a disease of growing years. The mean-age in this series, as in the previous one, was nine years. True hematogenous osteomyelitis is very rare in adult life, and apparently runs a shorter, milder course. The mean-age for the patients who died was seven years, a slight shift under the mean-age of all patients, which possibly indicates a higher mortality among younger children, but primary acute hematogenous osteomyelitis is serious at any age.

Symptomatology and Clinical Course.—No attempt will be made to discuss fully the symptomatology or clinical variations of the disease, but a few important features of symptomatology, impressed upon us by our findings in this study, are herein noted. The statement that acute hematogenous osteomyelitis is not always easy to diagnose may be surprising, but it is accurate. The onset of the disease is usually sudden but it may not be fulminating. Sometimes a period of malaise, with mild pain in the region of a joint, may precede graver manifestations of the real trouble. It is very likely that in these instances parents do not realize how sick their inactive child is. Temperatures in many instances are not taken and recorded. The fact that patients

may later develop most intense signs of septicemia, after the initial symptoms were mild pain, a limp, and low grade fever, would seem to indicate that the septicemia in these cases originates slowly from the secondary focus of infection in the bone and not as a manifestation of a probable haphazard and sporadic bacteremia from an original infection such as a furuncle. The temperature rises gradually or abruptly, usually to 102° to 104° F. A chill is not uncommon but it does not occur as a first symptom. In three instances in the 66 cases convulsions were recorded. They are the result of fever in young children.

The local symptom, initially, is pain and pain alone. At the onset pain may be mild but as the disease progresses it may appear to be excruciating, particularly in young children. It is generally in the region of the joint. The patient resents any movement of the involved extremity. The pain is usually well localized but it may be diffuse and poorly localized, causing great confusion as to the exact site of the disease, particularly when it involves the upper end of the femur or the ilium. Pain may involve the whole thigh when the disease is in the region of the hip joint, and because movement of the knee results in severe pain, loc. zation of the disease may erroneously be judged to be low in the femur. In these instances palpation of the thigh at any area may result in excruciating pain. This is undoubtedly due to radiation of the pain from the region of the hip as frequently occurs when lesions are localized there. The exact location of acute hematogenous osteomyelitis in the region of the shoulder joint may likewise be confusing. These are very significant facts because in the early stages of the disease, the only points on which to make a diagnosis of acute hematogenous osteomyelitis are the pain and high fever subjectively, and the tenderness objectively. Swelling, redness, heat and induration of soft tissues may make their appearance as the disease progresses. Roentgenograms, as will be seen later, are not helpful.

Every early feature of acute hematogenous osteomyelitis may be present and the disease subside without the bone ever showing changes. In such a case the bone might be drilled since the usual indications for the diagnosis at that stage are fulfilled. Too much haste in such an instance may convert a subsiding periostitis into a prolonged osteomyelitis. We have observed three such cases. The temperature chart of one is shown in Chart 1.

Rapid pulse and other signs of sepsis may be expected including stupor, irrational states, and coma in more severely ill patients. Occasionally another bone, another organ, or the subcutaneous tissues may be the seat of metastatic lesions. In one patient in this series an eye was lost because of metastatic abscess and in another instance a severe acute subcutaneous infection in the region of the buttocks occurred. Pneumonia, empyema, pericarditis, and pathologic fracture, are also complications observed in this group of cases.

Roentgenologic Evidence.—In studying these cases in detail and also in the previous group, it was found that there was no uniformity in appearance of positive evidence of acute hematogenous osteomyelitis in roentgeno-

grams. Roentgenograms were negative during the first week of the disease in all cases except three. In one instance the roentgenograms showed osteoporosis after the disease had been present for four days only. In two more cases osteoporosis was present on the fifth day of the disease. In many cases roentgenograms remained negative as long as 8, 9, 10, and even 14 days, to become positive later. Usually there is appearance of some evidence of the disease in the bone on roentgenograms taken between the eighth and tenth day of the disease. The first significant sign is usually a slight osteoporosis in a small circumscribed or diffuse area (Fig. 1), *and/or*

8th day of disease. 8th month after onset.

FIG. 1.—Roentgenograms taken on the eighth day of the disease and eight months after onset. The earliest sign of the disease is slight osteoporosis, as indicated by the arrow. Drainage only of an abscess was undertaken. This child, age 10, ran a very severe course. The osteomyelitis, as indicated by the subsequent roentgenograms, spread through osseous tissue, without elevating the periosteum. Recovery.

evidence of elevation of the periosteum. The roentgenograms, of course, serve as valuable evidences of the progress of the disease—its dissemination through the bone, the appearance of sequestra, and finally the marks of healing, the reappearance of calcium density, and sclerosis, with disappearance of osteoporotic areas (Fig. 2). Evidences in the roentgenograms indicate that the osseous spread of the disease is very rapid. Though the first roentgenograms taken may show a very small area of osteoporosis, those taken on the eighteenth and twenty-first days of the disease usually show the full spread of the disease. Roentgenographic evidence may rarely indicate a continued spread of the disease for several weeks after that. The full extent of involvement is probably usually present early on the eighth day, even when only a small area is noted roentgenographically. The fundamental changes have taken place and decalcification continues for days there-

FIG. 2.—Roentgenograms and final healed result in a case in which osteotomy was performed on the fifth day of the disease. There was a marked elevation of the periosteum in contrast to the appearance shown in Figure 1, but no sequestrum formed; a sinus resulted, necessitating a subsequent osteotomy a year and one-half after onset. The diffuse recalcification is a good example of how healing appears after the disease has subsided.

after, manifesting roentgenographically the full area involved between the end of the second and third week. No definite evidence of demarcation of the sequestra can be found in the roentgenograms before the fourth week of the disease. Sometimes evidence of a sequestrum is not present in the roentgenogram until the second or third month of the disease. In some instances evidences of sequestra never become apparent roentgenographically.

Further evidence of a surprising nature is found in the roentgenograms. Even though the disease may be clinically very severe, the area of osteoporosis may be relatively restricted (Fig. 3). A comparison of roentgeno-

1 month after onset. 7 months later.

FIG. 3.—Roentgenographic appearance of the process one month after onset and eight months after onset. On admission, the temperature was 104°F., and the child was very sick. No drainage and no operation was undertaken. In spite of this there was a minimum spreading of the disease and recovery took place in eight months. This is one proof that factors determining the extent of spread are not influenced by surgical intervention. It is not proof that surgical intervention should not be employed.

grams and the time of operative intervention upon the bone shows there is no strict relationship between the operation and the extent of spread of the disease in the bone. In a case where an operation is not performed or is withheld for days after the onset of the disease, the disease may remain localized to a small area in the bone. On the other hand, the disease may spread widely throughout the bone even though roentgenographic evidence was negative at the time an osteotomy was performed (Figs. 2 and 4). The spread of the disease in the bone is probably determined by the extent of vascular involvement, the retrograde thrombosis, and the balance of bone immunity to infection virulence and not to pressure. These facts contend severely with the usual impression that the spread of the disease may be countered by an early operative procedure. They do not, however, prove that an early operative procedure is not of value and is not indicated.

Localization of the Disease.—A single bone was involved in 57 cases. Multiple bones were involved in nine, or 13.8 per cent of the 66 cases (Fig. 6). The incidence remains surprisingly high, and coincides with the percentage of multiple bones involved in series reported by other authors (Wilensky[2]).

FIG. 2.—Roentgenograms and final healed result in a case in which osteotomy was performed on the fifth day of the disease. There was a marked elevation of the periosteum in contrast to the appearance shown in Figure 1, but no sequestrum formed; a sinus resulted, necessitating a subsequent osteotomy a year and one-half after onset. The diffuse recalcification is a good example of how healing appears after the disease has subsided.

after, manifesting roentgenographically the full area involved between the end of the second and third week. No definite evidence of demarcation of the sequestra can be found in the roentgenograms before the fourth week of the disease. Sometimes evidence of a sequestrum is not present in the roentgenogram until the second or third month of the disease. In some instances evidences of sequestra never become apparent roentgenographically.

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A total of 76 bones involved were found in the 66 patients; in seven, two bones were involved, and, in two, three bones were involved. The time or occurrence of the metastatic lesion is usually early within the first week of the disease but a secondary bone may become involved even years later. The bones involved are shown in Table I. The disease involves most frequently the metaphyses of bones with the fastest growing epiphyses. Thus, the lower end of the femur, the upper end of the tibia, the upper end of the femur are places of predilection for osteomyelitis. Next in frequency the metaphyses of bones of the upper extremity are found involved. Pelvic bones are not infrequently involved, but the ribs, spine, and head, are usually not the seat of true, acute hematogenous osteomyelitis.

TABLE I

THE RESULTS OF BLOOD CULTURES
ACUTE HEMATOGENOUS OSTEOMYELITIS

Blood Cultures in 66 Cases

Taken 36		
Positive 20 (one death)	Staphylococci 18 (90%)	
	Streptococci 2	
Negative 16 (44.4%)		
Staphylococcic septicemia and osteomyelitis—18 Cases—one death—(5.5%)		
Longest continuation of positive cultures—10 days.		

Pathology and Pathogenesis.—The usually accepted view of the pathogenesis of acute hematogenous osteomyelitis, is the one advanced by Starr,[3,4] who gave as evidence for his conclusions of the pathogenesis, the necropsy findings in a child, age two, who died of septicemia 48 hours after the onset of symptoms. Careful examination showed the infection in the bone to be just above the epiphyseal line, and for a comparatively small extent the periosteum was elevated in that region. The gross appearance showed inflammation localized to this region. He argued that infection usually beginning in the end-arteries of the metaphysis spread along the epiphyseal plate to the subperiosteal region, where it progressed, raising the periosteum around the shaft of the bone. Many arguments concerning therapy are based upon this conception of the pathogenesis. Now, in reality, it is far from proved. Careful study of the roentgenographic appearance of the disease in different cases, and at different stages, does not always bear out the idea that the inflammation spreads thus. There is some reason to believe that in certain instances the disease begins under the periosteum and spreads into the bone. Roentgenographic evidence of this is a small area of osteoporosis in the subperiosteal region and clinical evidence is the discovery of subperiosteal but not intramedullary pus (Crossan[5]). In other instances, roentgenographic evidence may indicate that the disease begins in the cortex at some distance from the metaphysis, that it spreads through the bone as an osseous cellulitis with or without elevating the periosteum. The periosteum does not always have to be elevated even when severe osteomyelitis is shown roentgenographically (Fig. 1). Brodie's abscess may be regarded as an abortive form of acute

hematogenous osteomyelitis. It is usually at some distance from the epiphyseal plate and the spread from such an initial focus in the cortex, if not aborted, may presumably be in both directions. The rapid spread of the acute infection with elevation of the periosteum, thrombosis of the artery, and sequestration of a large segment of the shaft, is rarer, in reality, than diffuse osteop-

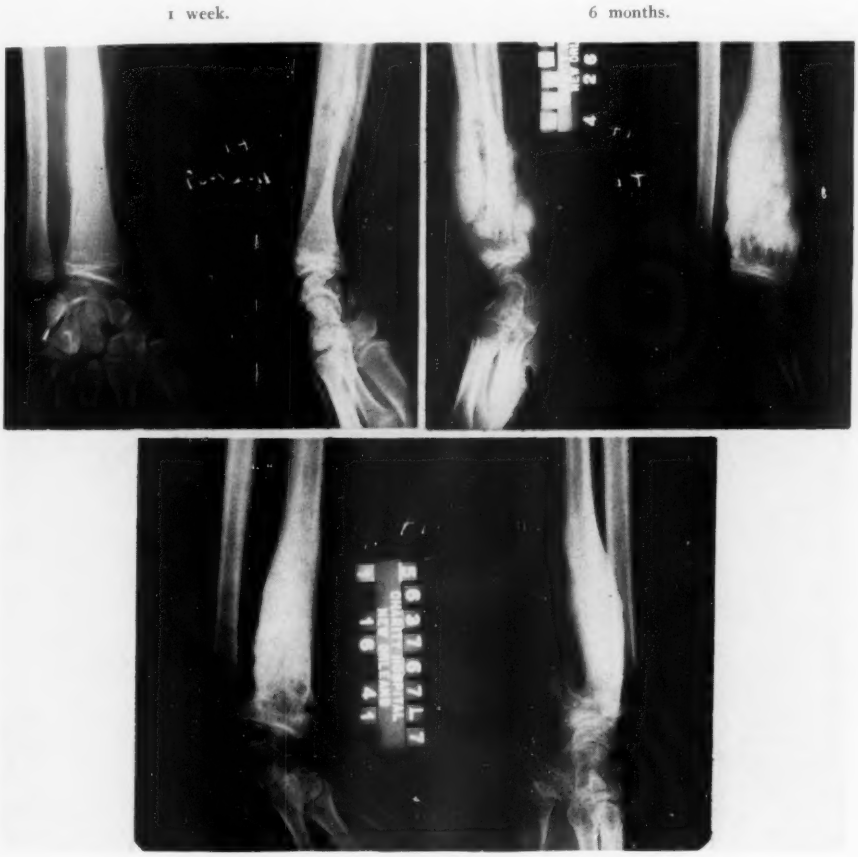

FIG. 4.—A window was put in the bone on the eighth day of the disease. A massive involucrum formed. A sequestrectomy was performed on two subsequent occasions. The child was clinically well one year after onset. In this instance the primary seat of the disease was in the diaphysis.

orosis occurring in the shaft with a low-grade periosteal reaction and gradual thickening of the periosteal part of the acutely inflamed bone, which the usual concept regards as necrotic.

One feature of the pathology and pathogenesis of the disease, so far insufficiently emphasized, is that it is *a vascular disease or an intravascular one.* The most pronounced features of it are due to the fact that the etiologic factors responsible for the systemic symptoms and the changes in the bone are initially in the vessels. If one were to base therapeutic indications on pathologic conception, instead of on careful studies to evaluate the measures,

it would seem just as sound, or more so, to advocate ligation of a vein leading from that particular bone than to drill the bone with the hope of freeing pus or of hitting that particular nidus of infection which is intravascular and which is liberating organisms into the systemic vascular system.

Sequestration does not always take place in acute hematogenous osteomyelitis. At least, it cannot always be demonstrated roentgenographically nor at operation (Figs. 1 and 5). In such instances the bone is diseased and in-

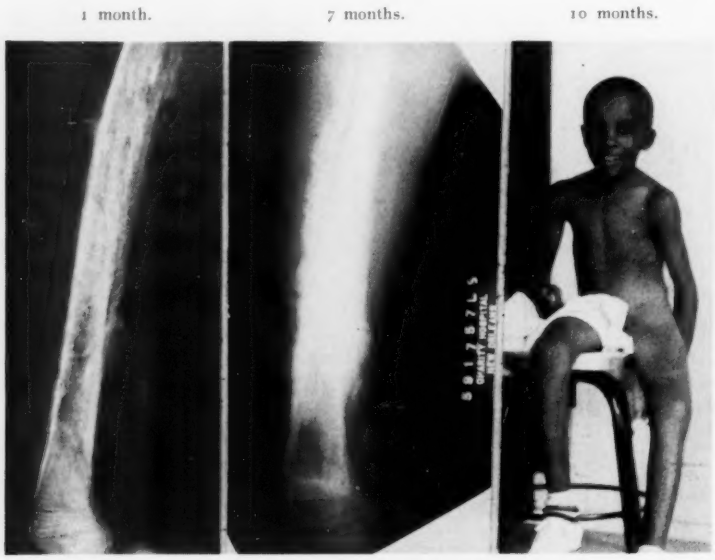

FIG. 5.—Roentgenograms show the appearance of the bone one month after onset and seven months after onset. No operation was performed. There was no drainage. The patient made an uneventful recovery and was well in ten months; active and playing. There was a massive periosteal thickening surrounding the old bone, and thus the meaning of sequestrum becomes obscure. According to the usual concept, it is a dead, obnoxious piece of bone, with the implication that it must be removed before recovery ensues. "Sequestra" in hematogenous osteomyelitis are probably almost always viable.

flamed, though viable. What is regarded as sequestration itself may not be actual necrosis. Instead of sequestration being the result of elevation of the periosteum and cutting off the blood supply by gradual pressure increase due to pus, it may, theoretically, be the result of sudden thrombosis of an artery leading to a particular segment of the bone.[2] Sequestration, when it occurs, is usually a localized, rather small process, and, fortunately, does not often involve the whole shaft or a large length of the shaft of any bone.

In its chronic stage, osteomyelitis cannot always definitely be attributed to a sequestrum keeping up the infection. The recurrence of the infection in a bone, after it is once healed, may manifest itself as a reddish, tender inflamed area in the skin. Roentgenograms taken at this time sometimes show an osteoporotic area surrounding a firmly calcified sequestrum. It is just as common to find a diffused, thickened, ebonated bone showing no definite location of the infection in the bone itself. In these instances even exploration,

with osteotomy, may not show a definite sequestrum. It is conceivable that a reduction in the circulating staphylococcal-immune bodies may permit a dormant group of organisms to blossom again into an infection which is in viable bone and is not associated with necrotic bone.

Cressman and Blalock[6] have shown, experimentally, that sequestra may be absorbed or revitalized *in situ*. The question now arises as to whether the apparent sequestrum is in reality ever completely dead bone. What is a sequestrum becomes a very important question. Certainly, under our old concept of the pathogenesis and the indications for treatment, it was regarded as something very obnoxious, which must be gotten rid of before the patient is well. These facts and clinical cases, herein reported, showing healing of osteomyelitis without ever having drainage, raise a doubt as to whether that conception is accurate.

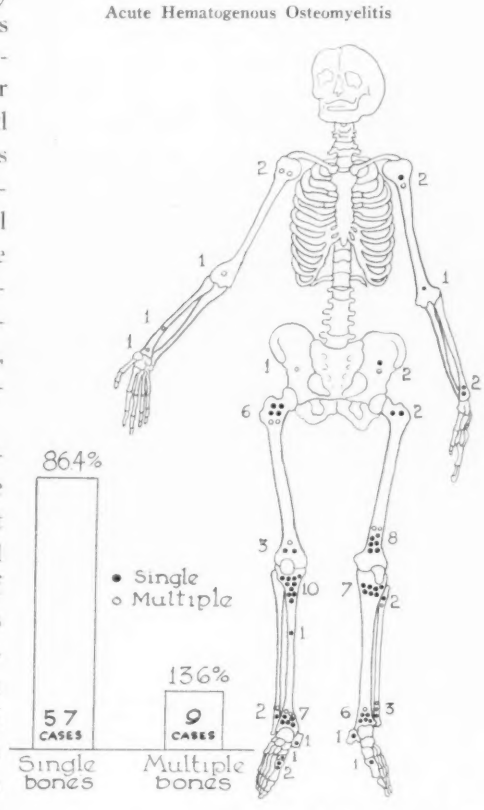

FIG. 6.—Illustrating the distribution of acute hematogenous osteomyelitis in 66 cases, with a total of 78 bones involved.

Blood Cultures.—The significance of blood cultures in acute hematogenous osteomyelitis is not clearly established. Baker and Shands[7] found that 70 per cent of patients with acute hematogenous osteomyelitis, with proven staphylococcus septicemia, died and, with this as a basis, urged the efficacy of staphylococcus antitoxin since its use in a similar group resulted in only 25 per cent mortality. The mortality for staphylococcus septicemia was not found to be so high in our series. Blood cultures were taken and were reported on 36 of the 63 cases. Out of the 36, 16, or 44.4 per cent, were negative, leaving 20 cases of acute hematogenous osteomyelitis with proved septicemia. One, or 5 per cent, of these patients died. Eighteen of the 20 positive cultures showed staphylococci (Table I). One of these was the patient who died (5.5 per cent mortality for staphylococcic septicemia). Six of these 18 cases with staphylococcic septicemia were treated with antitoxin, leaving 12 cases not so treated, with one death (8.33 per cent mortality for staphylococcic septicemia and osteomyelitis untreated with antitoxin). Unfortunately, blood cultures were not requested or not taken in three other fatal cases and in 27 other survivors.

In studying these cases it is apparent that repeatedly positive cultures do not necessarily give a bad prognosis. In one case, cultures remained positive over a period of ten days, the highest number of colonies reported per cubic centimeter being 20. Most of the cases showing positive cultures had only one culture taken. In this study, at least, staphylococcic septicemia

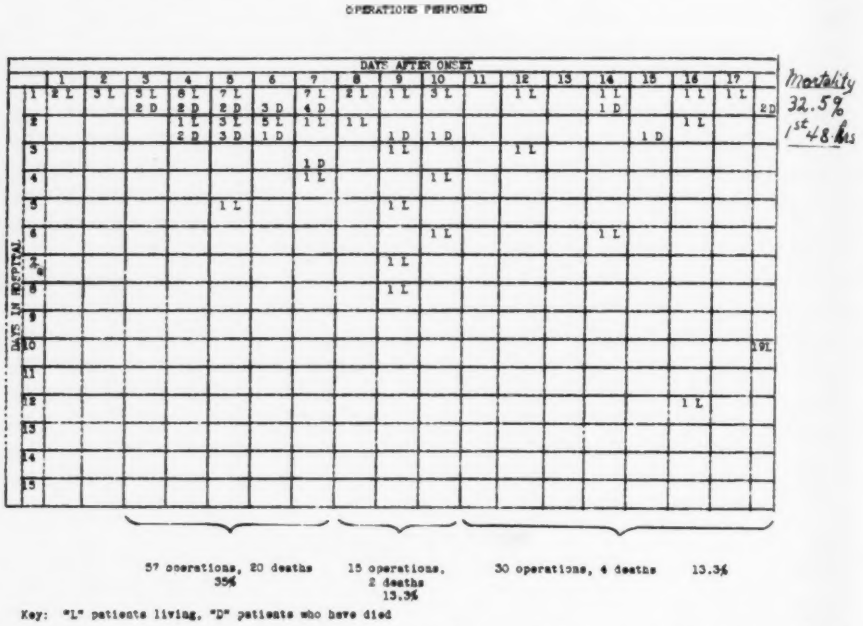
OPERATIONS PERFORMED
DAYS AFTER ONSET
DAYS IN HOSPITAL BEFORE OPERATION
Mortality 32.5% 1st 48 hrs
57 operations, 20 deaths 35%
15 operations, 2 deaths 13.3%
30 operations, 4 deaths 13.3%
Key: "L" patients living, "D" patients who have died

FIG. 7.—The living and dead patients in the first group of 112 cases, arranged according to the days after onset of the disease on which they were operated upon, and according to the days in the hospital before their operation was performed. The mortality in the first 48 hours was 32.5 per cent. The mortality between the third and seventh day of the disease was 35 per cent. In spite of this, operation itself may not have been responsible for this high mortality, but failure to prepare the patient properly before operation most certainly was a big factor.

did not prove to be as lethal as it may have been found to be in previously reported series, and certainly not as vicious as the factor or factors responsible for the astounding mortality in our first series. The mortality for cases with positive cultures in the first series, 1930–1936, was 50 per cent. Perhaps, to explain the high mortality for acute hematogenous osteomyelitis, one will have to look for other causes, some of which might have been masquerading under the guise of a helpful measure.

Operative Procedures.—The fact that over 40 surgeons performed the operations upon these patients is obvious enough reason for expecting a variety of opinions and operative indications. In the first group studied, 71.4 per cent of the patients were operated upon within 48 hours, and in 90 per cent of these the bone was opened (Fig. 7). In this group of 66 cases, 56 were operated upon. The remainder had no operations, and of these ten, two died. Single operation was performed on 28 patients (19 incisions and nine osteotomies). Mutiple operations were performed upon 26 patients (72 operations) (Table II).

TABLE II

ACUTE HEMATOGENOUS OSTEOMYELITIS

66 Cases—Operations Performed

Single Operations—28 Cases
Multiple Operations—26 Cases (72 Operations)

	Deaths
Operations within 48 hours—24 (osteotomy 18)	1
Operations after 48 hours —32	1
No Operations —10	2

Twenty-four, or 36 per cent, were operated upon within 48 hours of admission (71.4 per cent in the first group). One of these, or 4.2 per cent, died. Eighteen, or 75 per cent, of this group of 24 cases had the bone opened at the first operation.

Twelve cases had no operations on first admission, two died. Three were aspirated, only one was subsequently incised; one had a subsequent operation upon the bone, with saucerization; ten, including the two deaths, were not operated upon.

Early operation upon the bone did not always result in prompt subsidence of systemic signs of sepsis (Chart 2), nor, as has been stated in discussing roentgenographic features, in limiting the spread of the disease in the bone. The systemic reaction in acute hematogenous osteomyelitis is usually prolonged, with or without drainage (Chart 3), but may subside promptly (Chart 4) even though the bone shows definite roentgenographic changes.

Wound Culture.—Cultures were reported from the wound in 46 of the 66 patients. Forty-one of these were reported as positive. The organisms found were: Staphylococcus—39, streptococcus—3 (one in mixed culture), and *Escherichia coli*—one (in mixed culture with staphylococcus).

Usually when blood cultures were taken the contaminant in the wound cultures was found to coincide with that in the blood stream. No particular therapeutic significance can be found in the wound cultures if blood cultures are available and reported positive. In the absence of positive blood cultures, however, cultures from the wound may be very significant in directing the type of therapy.

Mortality.—In the entire series of 178 cases, 31 patients died, a mortality of 17.4 per cent. More interesting is the comparative mortality for the cases in the first group (from 1930 to 1936, inclusive) and that for the second series of 66 cases, from 1937 to 1940, inclusive. In the latter group the mortality was 6.6 per cent (four deaths in 66 cases), in contrast to the astounding mortality of 24 per cent for the previous group studied (1930–1936).

In the first group, 107 of the 112 cases were operated upon. In 77 patients the operation was performed within 48 hours after admission. In the group operated upon within 48 hours the mortality was 32.7 per cent. In relationship to the duration of the disease, the mortality was also high when operation was performed between the third and seventh day. The reduced mortality, concomitant with fewer emergency operations and less radical operative procedures, is no indication that operation was responsible

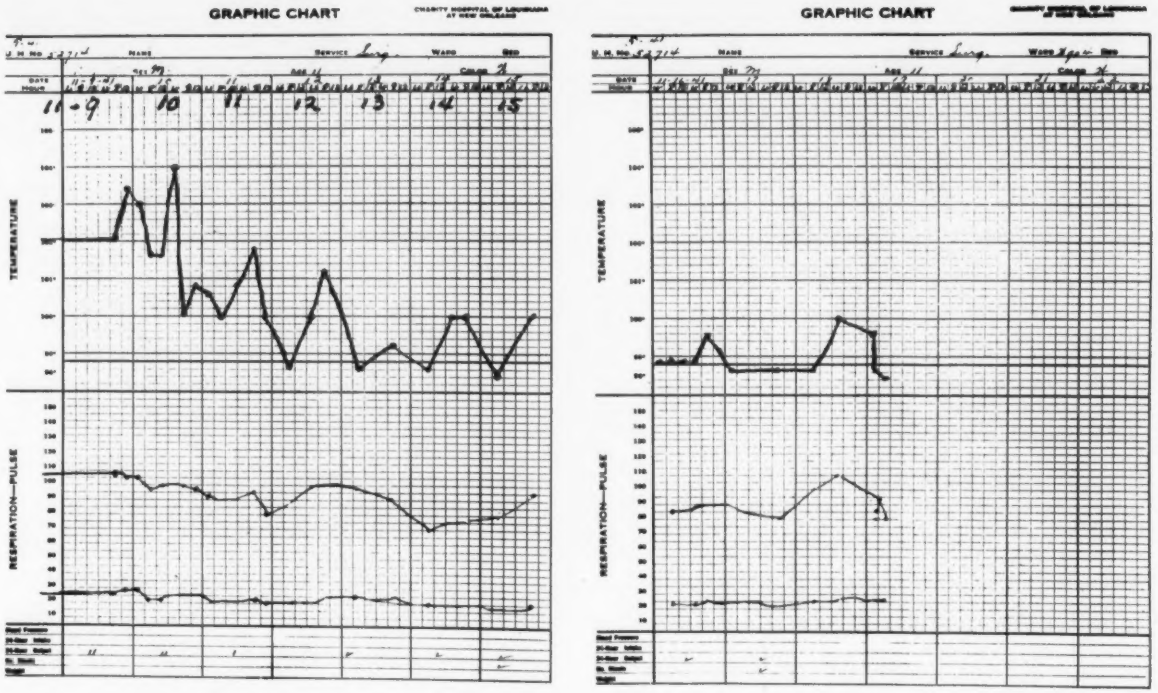

CHART 1.—The temperature chart of a boy, age 11, who 36 hours before admission developed pain in the region of his knee after sharply hitting it. He quickly developed fever which went to a maximum of 104°F. Objectively, there was marked tenderness over the upper end of the right fibula and tibia, and the clinical diagnosis, without reservation, was acute hematogenous osteomyelitis. Under sulfathiazole and rest the temperature quickly subsided. The process never produced changes in the bone. It is, thus, possible to have every feature of acute hematogenous osteomyelitis fulfilling every requirement for diagnosis with no osseous changes recognizable roentgenographically at any time. The only way to make the diagnosis early in the disease is pain subjectively, and tenderness objectively. Osteotomy in this case would have been a mistake, probably a grave one, converting a periostitis into osteomyelitis.

for the mortality. It does indicate that operation alone will not save patients, and that other measures probably deserve credit for the improved mortality. Pemberthy's and Weller's[8] series of 19 cases, with no deaths, all of which had osteotomy performed soon after admission to the hospital, shows that early and radical operation is not only consistent with, but may be essential for, the lowest possible mortality. On the other hand Hoyt, Davis and Van Buren[9] reported that without any operative procedure eight patients recovered with no deaths in the series. Only one had a residual draining sinus.

RESULTS

Attempts were made to estimate the final results. Information was gathered on 42 of the 66 patients in the recent series. Only 18 out of the entire group were personally observed and examined during the summer of 1941. The remaining estimate of the final results up to that time was obtained from letter or from the Out-Patient Clinic charts. Eleven cases are reported by letter. A summary of the results, during the summer of 1941, is as follows: Actually healed—20 out of 66 cases (Fig. 8). The average time required for the patient to be well in these 20 cases was 17 months.

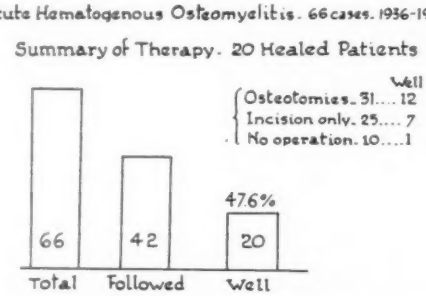

FIG. 8.—Graph showing results of follow-up study. Only one patient in the no-operation group was definitely followed. From latest information, at least three are believed to be well.

In an attempt to disclose the methods of value in the healed cases, and to elucidate the comparative value of measures used, 20 followed, healed cases were studied for procedures employed. In 14, osteotomy had been performed; in seven, incision and drainage only; and in one, no operation had been undertaken. In 31 cases in which the bone was opened, 14 (45 per cent) were well. Of 25 patients upon whom operation included incision only, seven (28 per cent) were well, and of ten patients who had no operations, two (20 per cent) were well. Though these figures are suggestive that osteotomy offers a shorter morbidity, they should not be accepted as conclusive. The time factor is not computed, and the conservative procedures have been used in a higher percentage of more recent cases. Only one case treated without operation could be traced. At least three were presumably well.

Plaster encasements, worn by 34 patients, about whom information could be obtained regarding the length of their use, showed that the average length of time an encasement remained on was 11 months. This only includes patients who are not still wearing plaster encasements. The length of time drainage continued in healed and unhealed cases was computed from information obtained on 35 cases. This was found to be an average of 19 months and four days.

Chemotherapy and Antitoxin.—Sulfathiazole was administered in 13 cases. In eight of these the blood culture was positive for staphylococci; of the remaining five cases the wound culture showed staphylococci in four. The wound culture was not reported in one case. These cases represented those in the latter part of the series, when the efficacy of the use of sulfathiazole for staphylococcic infections was more firmly established. One of the patients to whom sulfathiazole was given died. This patient was admitted two weeks after the onset of the disease, in an extremely critical condition.

The administration of sulfathiazole is not to be accepted as a "cure all." Even though the level may be above 7 mg.%, the blood culture may be positive (Case 49, which died). Blood cultures may remain positive over long periods of time, even though sulfathiazole is being administered (Case 69). The culture was still positive after ten days, though both sulfathiazole and staphylococcic antitoxin had been administered. The highest blood sulfathiazole level recorded in this case was 4 mg.%. The persistence of positive blood culture may be good evidence for vein ligation.[10] Sulfathiazole administration, certainly, does not result in any rapid drop in temperature, such as sometimes dramatically occurs after the drainage of an abscess in this disease or after immobilization in a plaster encasement. Its value, however, remains undisputed in staphylococcic infections. Sulfathiazole locally in the wound was not employed in any of these cases. Its use thus is undoubtedly rational.

Antitoxin.—In six cases, staphylococcic antitoxin was employed. In none of these instances did death result. The conclusions from such a small group, admittedly, are not valuable. In one instance, in which no other measure, such as drainage of an abscess, would acrount for it, the temperature fell dramatically after antitoxin was administered. On the other hand, the temperature was sustained until an abscess was drained in another patient, to whom antitoxin had been administered in adequate amounts. Out of six cases, in which antitoxin was given, five had sulfanilamide or sulfathiazole, or both.

The usual method of administration of antitoxin is to check the patient for sensitivity and desensitize if necessary. Then 10,000–20,000 units of antitoxin are given in an intravenous infusion. The next day 20,000–60,000 units are given in an infusion. The administration is repeated in a period of 12, 24, or 48 hours, as clinical symptoms indicate. A total of 200,000–1,000,000 units may thus be administered.[11, 12]

In one case, staphylococcus toxoid was administered. This patient also received antitoxin at another stage of the acute process. Longacre[13] has reported encouraging results for the administration of staphylococcus toxoid to patients with staphylococcic infections. It is rational and may prove of great value, particularly in the chronic case, with an acute recurrence.

Although no deaths occurred among the patients treated with serum therapy, no definite conclusions should be drawn from its effectiveness. At present it can be considered as a safe adjuvant therapy, with evidence accumulating for its efficacy.

SUMMARY OF TREATMENT

In the study of these 178 cases of acute hematogenous osteomyelitis, obviously, certain convictions and impressions are gained as to the best method of treating the disease. The cases were carefully studied in an attempt to evaluate the best measures or combination of measures to employ. Conclusions were not always possible but some impressive information was obtained. More attention was paid to therapy for the disease in the acute stage, when it was primary and first came to the attention of the physician or surgeon. Less definite study has been given to the operative indications in the late or chronic stages of the disease.

The following are fundamental measures of great value in the therapy:

(1) Hydration and Electrolyte Replacement.—The basis of all treatment for acute hematogenous osteomyelitis must be an attempt to keep the body in physiologic balance. These patients are very sick, and are usually dehydrated. They lose fluids by vomiting and excessive perspiration as well as through other channels. These fluids must be replaced. On admission, after the preliminary check, an infusion of dextrose, 5 per cent, in normal salt solution, should be started. The administration of fluids and electrolytes should be guided by physiologic principles, depending on the age and size of the patient.

(2) Protein Replacements.—Extremely sick patients do not have an adequate protein intake; increased metabolism results in destruction of tissues; hemolytic organisms destroy blood cells, and severe anemia may advance rapidly. The replacement of blood cells and proteins in acute hematogenous osteomyelitis by repeated transfusions is the second fundamental for all therapy. Transfer of immune bodies into the recipient occurs. In this study, many more transfusions were administered in the second series of cases than in the first. Transfusion should be repeated daily, every other day, or every third day, depending on the severity of the infection and the condition of the blood. Transfusions may be small (100–200 cc.) or they may be large (500 cc. or more), depending on the age and size of the patient. The frequency and quantity of transfusion must be determined in the individual case, but it is absolutely essential to be constantly thinking of transfusion as a basic necessity in the disease. In this way, as the requirement for it arises, it will not easily be overlooked.

(3) Chemotherapy.—Chemotherapy has had ample proof of its value. In the absence of a postive culture, since most hematogenous osteomyelitis is due to staphylococci, it is reasonable to start the administration of sulfathiazole. Immediate cultures should be taken to verify the rationality of the type of chemotherapy employed. If streptococcus is the proved organism in blood culture, sulfanilamide may replace the administration of sulfathiazole. Sulfathiazole should be administered to children in daily doses of 0.2 Gm. per Kg. body-weight (up to 20 Kg.). Administration may, of necessity, be by intravenous infusion, in a 5 per cent solution, giving 0.06 Gm. for each

Kg. body-weight in 24 hours. During the administration of chemotherapy it is essential to watch the daily blood count and to watch the level of the drug in the blood stream.

(4) Immunotherapy.—Two recent advances, which may prove of great help, in the treatment of acute hematogenous osteomyelitis are staphylococcus antitoxin and staphylococcus toxoid. Very convincing experimental evidence has been advanced for the employment of antitoxin. Baker and Shands,[11]

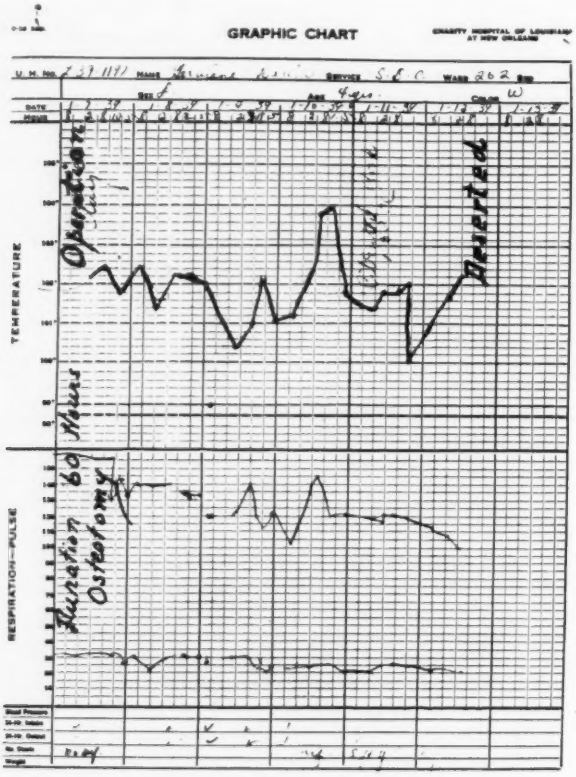

CHART 2.—The temperature chart of a child, age four years, who had an osteotomy performed 60 hours after the onset of the disease. There was no decided drop in the temperature nor subsidence of the systemic evidence of sepsis. The febrile course of acute hematogenous osteomyelitis may be prolonged with or without operation.

and others, have reported encouraging results clinically. The only disadvantage which might be an objection for its use is reactions. These are not common. A reaction was encountered once in this study of the six cases in which antitoxin was employed.

(5) Operation.—At the present time, one of the most controversial of all measures for acute hematogenous osteomyelitis, in the primary state, is the status of the value of operation. Our studies show that, in the first series, operation apparently did more harm than good. Certainly, one would not expect a greater mortality rate than 24 per cent if operation had been with-

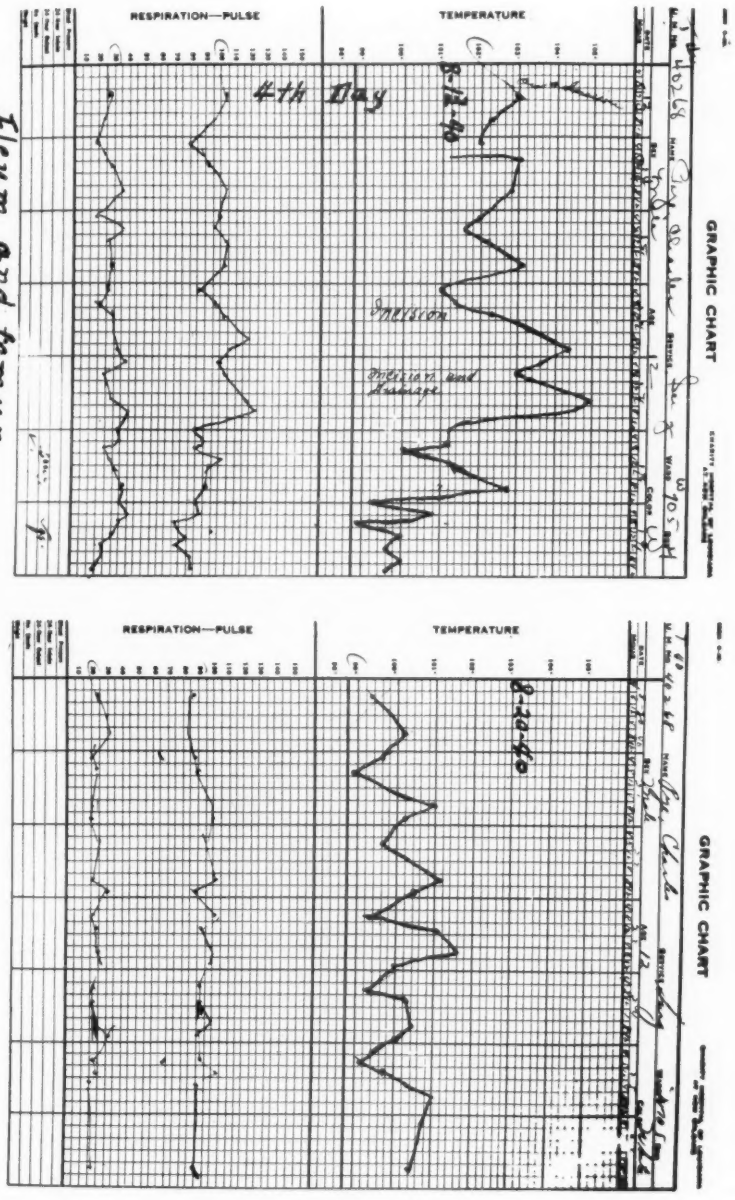
RESPIRATION—PULSE
TEMPERATURE
GRAPHIC CHART
4th Day
Ileum and femur
Incision
Incision and Drainage
RESPIRATION—PULSE
TEMPERATURE
GRAPHIC CHART

Chart 3.

held. Again, withholding operation, surprisingly, does not result in an extremely high mortality. It would seem that the reduced incident of operation, in the second series, had a great deal to do with the improved mortality statistics. On the other hand, of four deaths which occurred, operation was entirely withheld in two; in one even though the case was seen on the second day of the disease, and of the two remaining deaths, operation consisted merely in draining the abscess. Of the ten cases in the group in which no operation

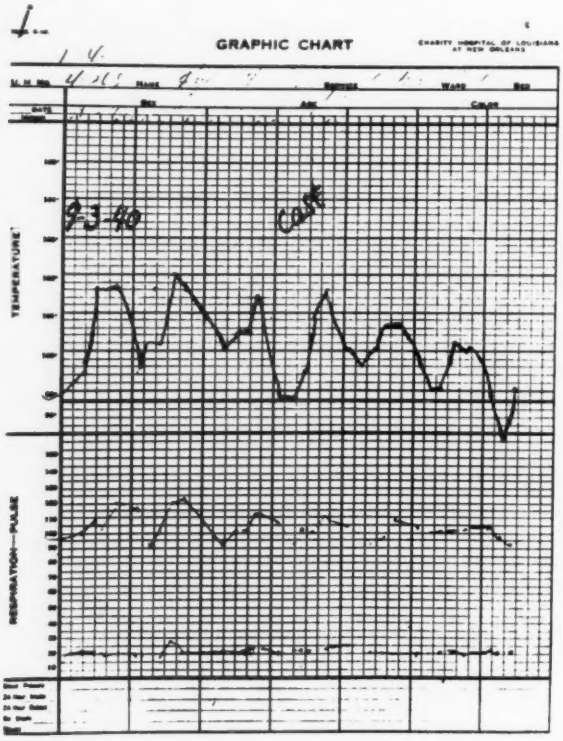

Chart 3A.

CHARTS 3 and 3A.—The temperature chart of a child, age 12, who was admitted on the fourth day of the disease. Incision and drainage of a soft tissue abscess resulted in slight abatement of fever. The subsequent application of a plaster encasement resulted in further improvement. The febrile course was prolonged. The patient was well in eight months.

was performed, death occurred in two. Certainly, these facts would make one wonder whether opening the bone in these cases would not have produced a more desired effect. Because of the numerous factors which come into the study of the improved mortality, it is difficult to evaluate clearly the changes which have gone on in the use or restraint of one therapeutic measure such as operation. We do not wish to draw any inflexible or iron-bound conclusion regarding operation, but believe that adequate drainage, whether by incision of soft tissues only, or by osteotomy, is indicated after the disease had endured long enough for pus to be expected (at least several

days). Disregard of this rule may result in serious mistakes by converting a case which is not osteomyelitis into one which is. Preparation enduring, at least, hours is essential before every operation. Operation is never so urgent that this principle should be neglected. Emergency operation, in the sense that a patient should be immediately taken to the operating room after admission and the bone drilled, carries a prohibitive mortality. Operation, whether incision or osteotomy, should insure adequate continued drainage, preferably by packing with vaselined gauze.[14] Vein ligation is indicated in cases with persistent positive blood cultures.

(6) Immobilization.—One of the most dramatic of all therapeutic measures is immobilization of an affected extremity. In a number of records where we have carefully checked the temperature charts, we found that the fever would be sustained in spite of operation, administration of chemotherapy and other measures, but, immediately, when the patient was put in a plaster encasement, without any other factor apparently being responsible, the temperature would decline sharply (Charts 3A and 4). Encasements were applied in the acute phase in the majority of these 66 cases. Never, as far as could be seen in studying the record, did the application of an encasement result unfavorably. This is one measure which always should be employed. It may be viewed with skepticism, but to any one who has had experience in absolute immobilization in acute hematogenous osteomyelitis, its value would not be questioned. Immobilization may be by an encasement or traction to affect the involved extremity.

(7) Late Operation.—Sequestra sometimes appear in the roentgenograms during the fourth week. Apparently, the removal of sequestra or infected bone may result in a more rapid healing than occurs if the patient is left indefinitely alone. The indications for secondary operations or operations in the third stage of the disease are the appearance of a definite sequestrum in the roentgenogram, only with, however, a continuation of the drainage and inflammatory reaction. Another indication for intervention would be the continual drainage of a sinus in spite of no definite roentenographic evidence of a sequestrum.

Unfortunately, we saw no evidence in this study that the morbidity of the disease is decreasing. Cases mentioned here have been repeatedly admitted to the hospital eight or ten times over a period of a few years. One had as many as six bone operations, and the disease was still active. This is nothing new in the morbidity of the disease. It is well known but not as well acknowledged. Possibly the developments in immunotherapy and chemotherapy combined with operative procedures will solve the prolonged disability in many of these cases.

SUMMARY AND CONCLUSIONS

The details of the study of 66 cases of primary acute hematogenous osteomyelitis admitted to Charity Hospital, New Orleans, between 1937 and 1940, inclusive, are given, and are compared with a previous study of 112

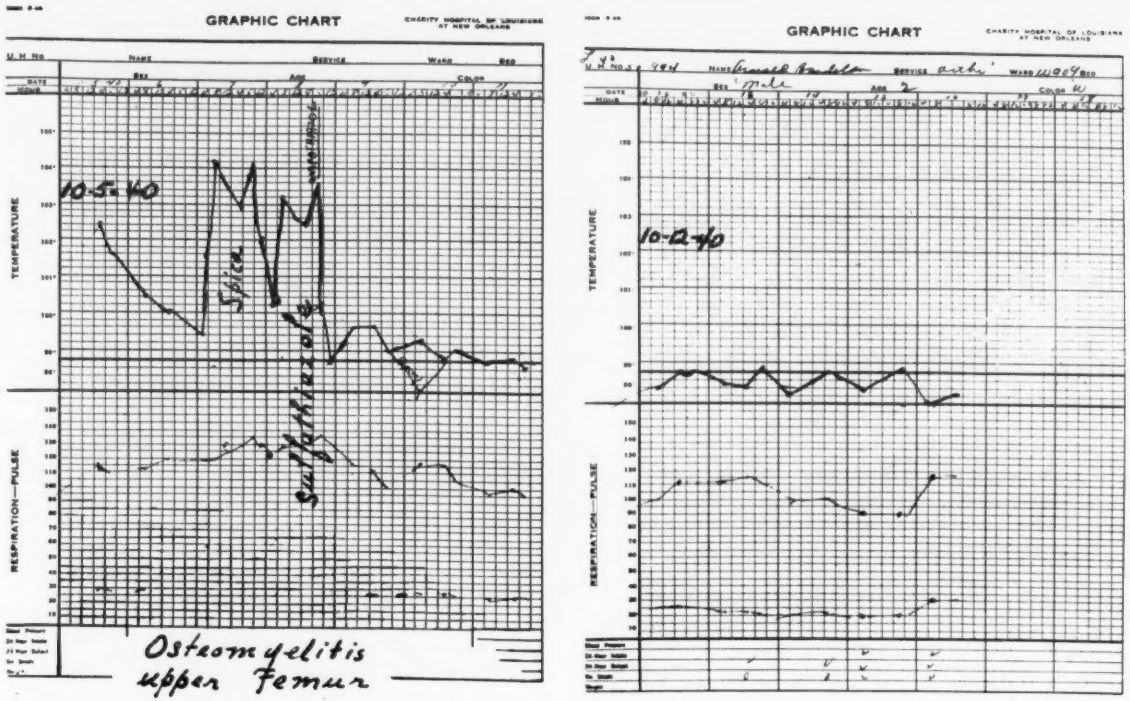

CHART 4.—Temperature chart of a child, age two months, with osteomyelitis of the upper end of the femur. The application of a spica and the administration of sulfathiazole resulted in prompt arrest of the disease, although osseous involvement was proved roentgenologically. No operation was performed.

cases occurring at the same institution from 1930 to 1936, inclusive. In the present group of 66 cases, the mortality was 6.6 per cent, in sharp contrast to a mortality of 24 per cent for the previous group. Efforts were made to disclose the variations in the methods of management which were responsible for the great improvement in the mortality.

Among the most important features responsible for the higher mortality were: Unjustified emergency operation before the patient had been properly prepared, and failure to reestablish normal physiology by fluid and electrolyte replacement and blood transfusions before operations were undertaken. In addition to these factors, new chemotherapeutic measures and immunotherapy have undoubtedly added additional favorable influence in the therapy of the disease. Our study shows, in comparing the two groups of cases, that operation itself performed after preparation is not a deleterious factor, and that opening the bone after essential preparation is no more harmful than incision and drainage.

Evacuation of pus, whether it be by simple incision or by osteotomy, would seem to be a favorable measure in the management of the disease. Osteotomy apparently does not influence the extent of bone involvement. An additional measure of extreme importance, from the operative viewpoint, is vein ligation in cases that have a continuous positive blood culture. Immobilization in a plaster encasement is a measure of great value and of far greater importance than is usually realized. It deserves wider application.

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DISCUSSION.—DR. MIMS GAGE (New Orleans, La.): I have enjoyed Doctor Mahorner's paper very much and think it quite timely, due to our activity in the present emergency. However, traumatic wounds, with fracture, resulting in osteomyelitis, differ etiologically from the juvenile type, but the principles of treatment are quite similar.

I have been interested in acute hematogenous osteomyelitis for many years, and in teaching students have varied somewhat from the accepted classification of the disease. In the past, as well as at present, the majority of surgeons class osteomyelitis as a single diseased state of the osseous system and have treated all cases as such. I believe that this has been mainly responsible for the present and widespread misunderstanding of the disease and, in a way, responsible for the high mortality. There has been very little effort made to distinguish, both clinically and by laboratory methods, the differences that exist in the various types of acute osteomyelitis.

We have many types of osteomyelitis, namely: (1) Acute osteomyelitis, with pronounced systemic manifestations due to toxemia and bacteremia (local reaction is not a part of the clinical picture); (2) profound systemic reaction (overwhelming toxemia without bacteremia), with minimal or absent local manifestations; (3) acute osteomyelitis, with quite severe local manifestations, with moderate systemic toxemia without bacteremia; (4) moderate to severe local manifestations, with mild systemic reactions; (5) minimal local and systemic reactions (Brodie's abscess); (6) minor local reactions, with benign systemic reactions (Garré's sclerosing type); and (7) the chronic form. In the past, and at present, these various groups are classed as acute osteomyelitis (except probably No. 6), and treated as such. One school advocates immediate operation; another, conservative treatment for a few days followed by operation; and the third school, nonoperative intervention, relying on the "sulfa-cure-all" drugs (sulfonamide group). I am convinced that the above conception (one disease) and the treatment advocated are, to a great extent, responsible for the appalling mortality.

As the *Staphylococcus aureus* is responsible for the greater number of cases (83 per cent), I think we should have some definite knowledge regarding the types and toxins produced by this formidable pyogenic organism. Spink* has isolated over 60 strains of staphylococci from patients, from both lesions and blood stream. We certainly should have some idea with regard to the various toxins liberated by the growth of the staphylococcus. The outline of Spink is quite interesting, and gives us a better insight into both the local pathology and the systemic reactions of acute staphylococcus osteomyelitis.

Spink names the following toxins: Hemolysis, dermonecrotoxin, lethal toxin, leucocidin, coagulase, fibrinolysin, enterotoxin, and the spreading factor of Duran-Reynolds.

The lethal toxin factor is of great importance because it can produce death within 15 to 34 hours. The other toxins are responsible for the variation in both the local pathology and the systemic reactions. Therefore, as stated previously, one cannot treat acute osteomyelitis as a single pathologic

* Spink, W. W.: The Pathogenesis and Treatment of Staphylococcal Infections. Internat. Clinics, **4**, 236, 1941.

process with one reaction. It must be evaluated from the outline given above, *i.e.*, the seven different clinical forms. The treatment should be based upon a thorough knowledge of both the local and systemic reactions. In those of profound toxemia and bacteremia, or in those with profound toxemia without bacteremia, and in those with moderate toxemia with bacteremia, immediate neutralization of the toxemia and suppression of bacteremia must be accomplished. In those cases that respond to neutralization of the toxemia but the bacteremia persists, methods must be instituted to delete the bacteremia. Therefore, in these cases staphylococcic antitoxin, in large doses combined with sulfathiazole and immobilization, should be given immediately, with immobilization of the involved limb. If the toxemia subsides and bacteremia persists, ligation of the common femoral vein of the lower extremity and axillary vein of the upper extremity is done, and sulfathiazole medication is continued.

Early operation is definitely contraindicated in the above type of case. Sustaining therapy must also be given. Infusions to maintain water balance and transfusions of whole blood and plasma, to replace and supplement corpuscular and protein loss, are given. Types 3, 4, and 5 should receive chemotherapy, sustaining therapy, early operation and immobilization. Plaster encasements for immobilization can be used safely in these cases. Types 6 and 7 are treated as elective cases. There is no definite indication for emergency treatment in the latter two types. I believe Butler's* report is of great significance as regards the surgical treatment in the acute phase. He reported 123 cases with bacteremia (positive blood cultures), with a mortality of 52 per cent; whereas in 122 cases without bacteremia (negative blood culture) the mortality was only 2 per cent. These mortalities represent those cases in which early operation was undertaken. I think we should ponder at great length on these figures. They demonstrate in a definite manner that which I have tried to point out in my discussion.

It is evident that we must have a thorough knowledge of all the factors involved; etiology, type of organism, type of toxin liberated, the systemic effect of the toxin on the organism, the local pathologic process, and its mode of extension, and the surgical principles involved, before we can intelligently treat cases of acute osteomyelitis and reduce the present high mortality and morbidity.

I wish to condemn the extensive habit and practice of "selling-short" sound, surgical principles, based upon pathologic physiology, for a limited supply of the "sulfa-cure-all" group of drugs, for indiscriminate application and use.

Dr. Joseph E. J. King (New York, N. Y.): I should like to ask Doctor Mahorner two questions: First, has the use of sulfathiazole helped in the prevention of massive destruction of the skull in cases of osteomyelitis; and second, has it been of any value in the treatment of osteomyelitis of the vertebrae? We have had a number of cases in which massive resection of the skull has been done in the past, before the day of chemotherapy. In these cases, regardless of the type of infection in the accessory nasal sinuses, the infection in the skull is usually due to *Staphylococcus aureus*. In view of the fact that Doctor Mahorner's cases have been so successfully treated with the use of the sulfonamide drugs, it is possible that the massive resections of the skull formerly undertaken may be eliminated.

* Butler, E. C.: The Treatment, Complications and Late Results of Acute Hematogenous Osteomeylitis Based on a Study of 500 Cases Admitted to the London Hospital, During the Years 1919–1937. Brit. Jour. Surg., **28**, 261, 1940–1941.

DR. L. D. BAKER (Durham, N. C.): I want to thank Doctor Venable for his remarks in regard to the work at Duke Hospital on staphylococcic infection, and for inviting me to discuss this paper.

The therapy Doctor Mahorner has outlined is essentially the same as we try to carry out at Duke Hospital. There is no disease which requires more acute surgical judgment or which has a wider range of severity than hematogenous osteomyelitis. In analyzing end-result studies, the cases should be grouped under several headings if the conclusions are to be of value. In conducting our studies we have classified hemolytic *Staphylococcus aureus* osteomyelitis under four headings: (1) Localized osteomyelitis without blood stream infections; (2) localized osteomyelitis with transitory bacteremia); (3) osteomyelitis with metastases and bacteremia but without toxemia; and (4) osteomyelitis with bacteremia and toxemia. It is the latter group that are, as a rule, so severely ill, and in outlining their therapy one must keep in mind the four actions of staphylococcus toxins; namely, (a) the hemolysis of red blood cells; (b) the destruction of young leukocytes; (c) the coagulation of plasma; and (d) the necrosis of tissue.

If a patient is unable to manufacture sufficient amounts of antitoxin, we feel that commercial antitoxin, as prepared by the Lederle Laboratories, is of inestimable value in either neutralizing or counteracting the actions of the staphylococcus toxins. When toxemia is present the patient is having his natural defenses destroyed, in that the polymorphonuclear cells are prevented from reaching maturity. In addition, there is a hemolysis of the red cells; a coagulation of the blood plasma, resulting in thrombosis of the vessels about the area of infection; and a necrosis of tissues. Occasionally a patient is capable of neutralizing the hemolyzing toxin and the leukocyte-destroying toxin, but at the same time he may be sensitive to the breakdown products of his own tissues. Like Doctor Mahorner, we believe that after proper preoperative steps have been taken, incision and drainage is indicated in the majority of cases. In addition to general supportive measures the use of staphylococcic antitoxin when indicated, surgery at the proper time, and as it appears that sulfathiazole is of benefit in this type of infection, its use is indicated as an adjunct in the therapy. The same cannot be said of sulfanilamide and sulfapyridine; in fact, in our hands, because of the toxic action on the vascular system of the two last-named drugs, we think they are contraindicated in the presence of a hemolytic *Staphylococcus aureus* infection.

DR. HOWARD MAHORNER (New Orleans, La., closing): If there is any one thing this sort of study shows, it is that the old doctrine, that the one important measure in treatment is operation, is a fallacy. The first slide (Fig. 7) with the tremendous mortality (24 per cent) showed that operation alone does not save lives. The improvement we have had is not because we withheld operation, but because the patients were better prepared. Patients with septicemia should be treated with modern physiochemical measures. There is no question about that, but there is some question about the time of operation in these cases.

How can one prove the value of operation? It is still an open question. No one could present better figures than Penberthy and Weller, who reported 19 cases in which they performed immediate operation with no mortality and relatively low morbidity. This looks as though operation were an important factor in therapy, but the same measures with and without operation may give a very small difference in mortality. This has to be studied from every angle. Most important is preparation for operation by replacement of fluids and electrolytes, blood transfusions, and chemotherapy.

Doctor Baker and Doctor Shands have shown immunotherapy to be of value in this condition. After preparation, adequate drainage is indicated, and in certain cases vein ligation is indicated. Immobilization in a plaster encasement is one of the most important measures. The late stage operation was not even considered in this study, because it is a question of improving the prolonged morbidity. That is going to be more difficult than reducing the mortality in the acute phase.

In reply to Doctor King's question: We have not had enough cases treated with chemotherapy to know whether we have had fewer metastatic lesions. The percentage of patients with multiple foci was just as high in this recent series.

SPLENECTOMY *

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GALVESTON, TEXAS

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THE REMOVAL of certain important organs of the body as a therapeutic measure comprises a large part of the surgeon's pharmacopoeia. The spleen is one of these organs. The reasons for its removal are not quite clear but by a trial and error practice it has been found that the removal of the spleen in certain instances results in the disappearance of dangerous symptoms. We do not like to acknowledge the fact that the reasons for the improvement and cure of these conditions following splenectomy are not understood. Until the cause of these diseases is understood we will continue to perform splenectomy for certain groups of symptoms.

The accumulation of results of many splenectomies has resulted in definite indication for the operation in certain diseases and equally definite contra-indications in other diseases associated with enlargement of the spleen.

Experience has shown that splenectomy is not indicated where splenomegalia is of septic origin or in myelogenous leukemia, pernicious anemia, lymphoblastoma and polycythemia vera, syphilis and malaria. On the other hand, there is no longer any doubt of the advisability of splenectomy in other diseases. These are purpura hemorrhagica, hemolytic icterus and less surely splenic anemia or Banti's disease. The results of splenectomy in the first two conditions are almost specific with few failures if the patient survives the operation. In Banti's disease good results may be expected early in the disease but late in the disease after there is great liver damage and ascites, in our own experience, the improvement is only temporary. Soon partial obstruction and repeated hemorrhages from *esophageal varices* prove fatal.

In young individuals there is difficulty in classifying many splenomegalia cases under one of the above named diseases. Splenectomy in such cases, if it can be undertaken with safety, may often be advisable. It is not our intention here to review the well known theories of diseases of the spleen, but to discuss operative procedures for reducing the mortality in splenectomy.

First, the preparation of the patient and selecting the proper time for the operation is of great importance. In the more advanced cases liver damage has already occurred and reinforced glucose feedings are not to be overlooked, while in severe anemia and particularly in purpura hemorrhagica (thrombocytopenia) transfusions and carefully watching for a favorable time for operation will save the severe cases.

Hemorrhage, both operative and postoperative, should be guarded against. The use of an incision which gives adequate exposure and at the same time is anatomically placed, so that a sound abdominal wall will be assured, has made us feel more confident of a successful outcome. The operation, which has been previously described,[1] is as follows: "The patient is tilted slightly to the

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

right side. The skin incision is begun in the midepigastric line, half way between the ensiform and umbilicus, and is extended laterally and downward to just above the crest of the ilium, which is in the line of the fibers of the internal oblique muscles. The anterior sheath of the rectus muscle is incised and the incision is carried across the fibers of the external oblique fascia to where it becomes muscular. The rectus sheath is dissected off its muscle upward and downward for a short distance and the muscle is retracted medially. This exposes the posterior sheath which is incised across from the linea alba outward and downward and between the fibers of the internal oblique. The transverse muscle is cut in the same line without separating it from the internal oblique. The tenth intercostal nerve is retracted with the rectus muscle, while the eleventh nerve is cut and the twelfth is retracted laterally.

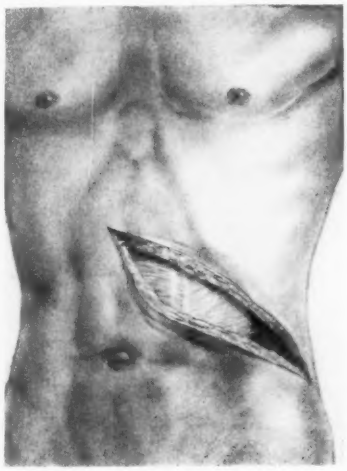

FIG. 1.—Incision parallel to costal border from midline to just above anterior superior spine.

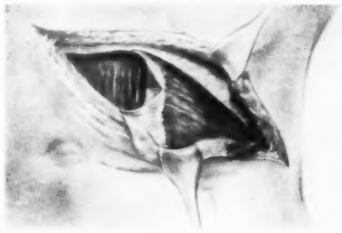

FIG. 2.—Anterior sheath of rectus and fascia of external oblique incised.

FIG. 3.—Anterior sheath disected free of rectus and rectus retracted medially.

"The use of a gastric suction tube put in place before the anesthetic is started, to collapse the stomach, gives greater room, and if it is retained for 24 to 48 hours it lessens the danger of displacing ligatures off the greater curvature of the stomach and also results in a smoother convalescence.

"The ligation of the splenic artery may not be visible, but its pulsation will be felt along the upper border of the pancreas when the lesser peritoneal cavity is opened. Care should be taken not to tear or include the splenic vein in the ligature. Almost immediately the spleen will reduce in size, thus making the gastrosplenic vessels accessible for severing between ligatures placed well away from the stomach. The separation of the spleen from the splenic flexure of the colon and upper pole of the kidney is next done, with careful ligation of all structures severed. Only now should the spleen be delivered out of the abdomen. After the spleen has been freed of its attachment to the diaphragm,

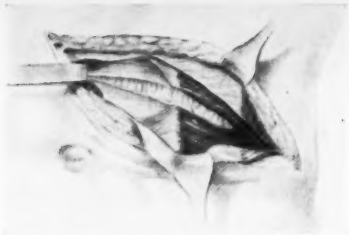

FIG. 4.—Posterior sheath of rectus and peritoneum incised and continued between fibers of the internal oblique and across transversus muscle.

FIG. 5.—Lesser peritoneal cavity entered and splenic artery, (along upper border of pancreas) ligated.

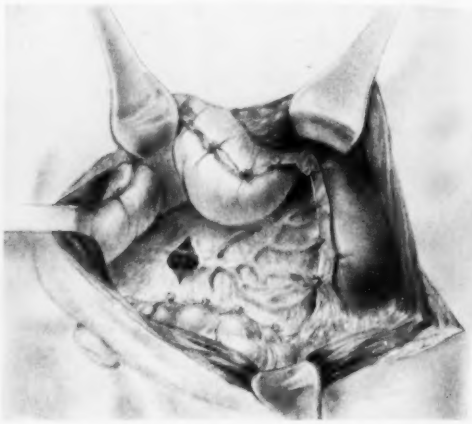

FIG. 6.—Gastro-splenic omentum is divided between ligatures all the way to the diaphragm. Also splenocolic ligament is divided.

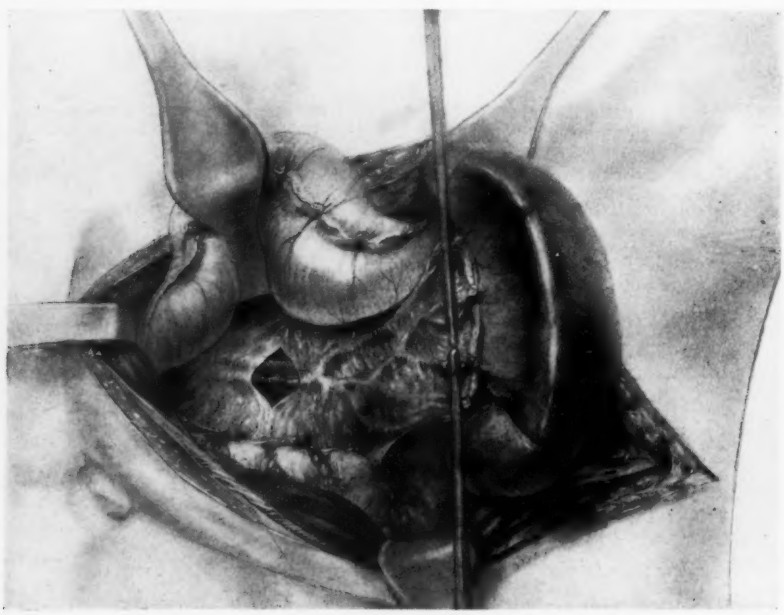

FIG. 7.—The spleen is then delivered out of the abdomen, the remaining pedicle divided and ligated.

the remaining hilus structures are clamped and then ligated. Following removal of the spleen, there is good exposure of the diaphragm and oozing vessels may be clamped and tied or coagulated with the radiocautery. Thus a dry bed is left and the necessity of packing with gauze is obviated. A continuous stitch sutures the posterior rectus sheath and the transverse and internal oblique muscles with the peritoneum. A second suture closes the anterior rectus sheath and external oblique fascia. A strong abdominal wall results.

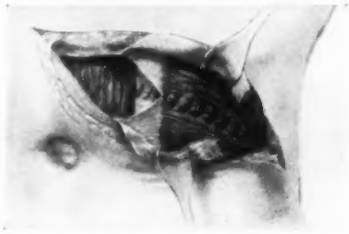

FIG. 8.—The posterior sheath of the rectus, internal oblique, transversus and peritoneum closed in one layer.

"The incision is unanatomic in that the fascia of the external oblique, as well as of the transverse muscle, is cut across its fibers. The injury to the intercostal nerve leaves no permanent evidence of damage, either to sensation or muscle control."

FIG. 9.—The anterior rectus sheath and external oblique fascia is closed with a second layer.

A review of a fairly large series of splenectomies shows a mortality of 9 to 30 per cent. In general hospitals where there is a large number of advanced cases requiring splenectomy the mortality is very high. These patients are bad risks and a certain mortality is unavoidable. On the other hand, deaths not infrequently result from hemorrhage incident to the operation from the tearing of vessels or the accumulation of blood intra-abdominally from oozing of blood from the splenic bed. In a series of 30 splenectomies with five deaths, at autopsy, there were found in three cases intra-abdominal accumulations of blood in excessive amounts which might have been avoided with a better exposure of the diaphragm and direct attention to capillary bleeding.

FIG. 10.—Skin incision closed.

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[1] Singleton, A. O.: Splenectomy. Surg., Gynec., and Obstet., **70**, 1051–1053, June, 1940.

DISCUSSION.—DR. J. D. RIVES (New Orleans, La.): I would like to express my appreciation of Doctor Singleton's very interesting demonstration of his careful anatomic technic of splenectomy. I would also like to comment on one problem upon which he did not touch, that is, the mobilization of the spleen in the presence of very extensive and dense adhesions that cannot be separately divided and ligated. In some instances, the peritoneal covering of the spleen may be completely fused with the parietal peritoneum covering the diaphragm and the lateral abdominal wall. I have found that under such circumstances an attempt to separate the spleen from the parietal wall usually

results in deep laceration of the spleen, which is followed by violent hemorrhage. This hemorrhage is chiefly from the spleen itself rather than from the adhesions. I have found that under such circumstances if an incision is made through the parietal peritoneum anterior to the attachment of the adhesions, the loose areolar tissue underlying the parietal peritoneum provides a line of cleavage in a relatively avascular plane. The hand may be inserted into this plane and, by rapid blunt dissection, the entire spleen may be mobilized with great ease and a minimum of hemorrhage.

When the spleen is delivered it is covered by a double layer of peritoneum, that is, both the parietal and the visceral layers. The remainder of the procedure is then carried out in the conventional manner. This maneuver exposes the posterior surface of the lienorenal ligament uncovered by the peritoneum, and the identification of the structures of the pedicle, including the tail of the pancreas, is comparatively easy. A large raw surface is left behind but this may be readily covered by omentum if desired. It is probable that the greater curvature of the stomach would become adherent if this were not done, but it is doubtful whether or not this would interfere seriously with the function of the stomach. This method is not frequently needed, but it has saved me very serious difficulties on two occasions.

DR. R. L. SANDERS (Memphis, Tenn.): Doctor Singleton has been a champion of the transverse incision for many years, and it was largely because of his successes that I became interested in this approach to the upper abdomen.

My experience with the transverse incision has been confined chiefly to operations on the gallbladder and ducts, perforated peptic ulcer, and congenital pyloric stenosis in infants. For splenectomy, the transverse incision on the left has been found most satisfactory. We have now applied the various types of approach in approximately 600 cases. In our early cases, the incision was made across the linea alba; with this technic, however, a few infections developed, followed by separation of the wound and hernia. Later, we adopted the method suggested by Doctor Schwyzer, of St. Paul, and this incision of Doctor Singleton's, and, so far as we know, none of the patients has had a hernia. The incision is admirably suited to the Ramstedt operation for pyloric stenosis. Disrupted wounds in crying babies are sometimes fatal in these cases. Practically all such deaths occur following the employment of the vertical incision. When the incision is transverse, crying tends to draw together, rather than separate the wound edges, and thus there is little danger of wound disruption.

The transverse incision is also especially advantageous in operations upon obese individuals beyond middle age, whose abdominal walls are composed chiefly of fat and thinned-out muscles and fascia. As these patients generally take the anesthetic poorly, respiratory effort is increased and closure of the vertical incision is difficult. This difficulty is obviated by the use of the transverse approach.

Unquestionably, the transverse incision has a definite place among surgical approaches, and once the technic is mastered, its advantages are readily appreciated.

THE USE OF ESTROGENIC SUBSTANCES IN THE PRE- AND POSTOPERATIVE TREATMENT OF HYPERTHYROIDISM*

FURTHER OBSERVATIONS

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FROM THE DEPARTMENT OF SURGERY, SCHOOL OF MEDICINE, TULANE UNIVERSITY, NEW ORLEANS, LA., THE TOURO INFIRMARY; AND THE CHARITY HOSPITAL OF LOUISIANA

DURING the meeting of the Southern Surgical Association, in 1940, at Hot Springs, Va., one of us (A. H. S.[1]) discussed the use of estrogenic substances in conjunction with the surgical treatment of hyperthyroidism. The results observed in a small series of cases in which this supplementary medication was employed, have been reported,[2] along with a review of the rationale for the employment of this form of therapy. The present report includes additional recent observations which confirm the previous findings.

Observations upon which the employment of estrogen therapy in hyperthyroidism is based include those by Sherwood and Bowers,[3] and Sherwood,[4-7] which demonstrated the basal metabolism lowering effect of estrogens in thyroidectomized animals rendered hyperthyroid by the feeding of thyroid substance; the observations by Starr and Patton,[8] that an increased sensitivity to thyrotropin exists in hyperthyroidism; the thyroid stimulating effect of thyrotropin,[9-21] and the direct metabolism stimulating effect of certain anterior pituitary secretions.[22-29] The exact mechanism of basal metabolism lowering observed in hyperthyroidism is not agreed upon. Sherwood and Bowers,[3] and Grumbrecht and Loeser[30] advanced the hypothesis that the basal metabolism lowering effect is mediated through an inhibitory influence exerted by the estrogenic substances on the anterior pituitary. Later observations by Sherwood,[6, 7] however, led him to believe that the basal metabolism lowering effect of estrogenic substances is due to a direct hormone antagonism in the tissues rather than to an influence on the thyroid gland either directly or by mediation through the pituitary gland. In addition to any possible effect which retardation of anterior pituitary thyrotropic hormone secretion might have in reducing thyroid activity, inhibition of the direct tissue metabolism stimulating effect of anterior pituitary secretions[22-29] might at least partially account for any lowering of the metabolic rate following the administration of estrogenic substances to patients with hyperthyroidism.

Eleven cases, including five previously reported,[1] constitute the basis for the present report. As controls, 11 cases of surgically treated hyperthyroidism, which received practically the same basic preoperative therapy as did the cases which were treated with estrogens, were studied.

The race, sex, and age factors in the control and estrogen treated groups are shown in Chart 1, which also shows the incidence of iodine-fast cases in the two groups. Average age was considerably greater in the control group.

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

The cases which received estrogen therapy presented clinical evidence of greater toxicity (nervousness, tremor, apprehension, palpitation, purposeless movements than did most of the cases in the control group. This clinical impression of greater toxicity in the group selected for estrogen therapy was confirmed by the slightly higher average basal metabolic rate on admission,

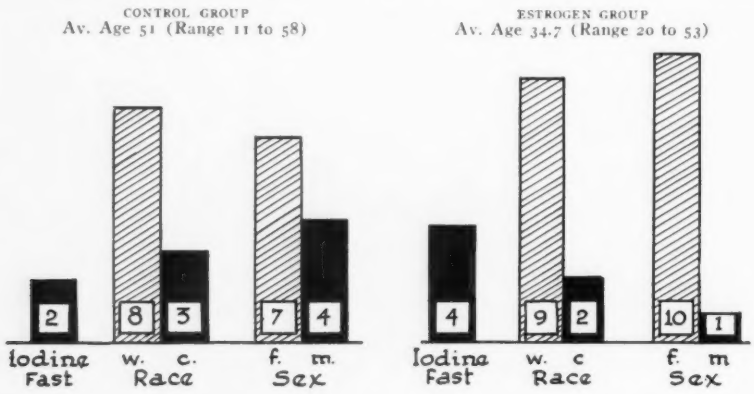


CHART 1.—Showing age, incidence of iodine-fastness, race and sex in control and estrogen treated cases.

+47.7 per cent, as shown in Chart 2, and a higher average pulse rate, 113 beats per minute (Graph 1), than in the control group, in which these values were +46.9 per cent, and 109, respectively. Three cases of the estrogen treated group and four of the control group had nodular toxic goiters. The remaining cases in both groups had diffuse toxic goiters. Of the 11 cases which received estrogen therapy, four were estimated to be sufficiently toxic to require two-stage operations, whereas two-stage operations were performed in only three of the 11 cases in the control group. In the instance of cases in which multiple-stage operations were performed, only those observations which were made preceding, during, and immediately following the first stage are included in the data presented. Four of the 11 estrogen treated cases had received iodine elsewhere for periods varying from four to eight months prior to hospital admission. Of the control group, one case received roentgeno-therapy and another case received Lugol's solution before hospital admission. All one-stage operations consisted of subtotal thyroidectomy, and in multiple-stage operations, one lateral lobe or a lateral lobe and the pyramidal lobe were removed at the first operation. Estrogen therapy was continued following

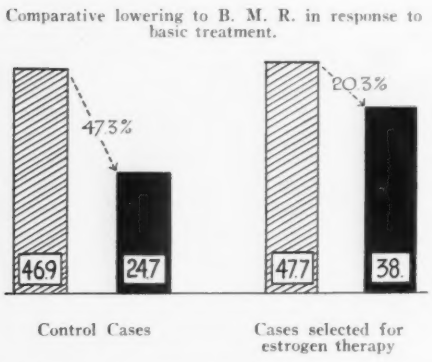


CHART 2.—Showing average basal metabolic rate on admission and following "basic" therapy in control group and group selected for estrogen therapy.

operation when only one lobe was removed at the first operation. There were no deaths in the estrogen treated cases; one patient in the control group, having a basal metabolic rate of +81 per cent on admission, died following a one-stage subtotal thyroidectomy.

In both the control and the estrogen treated groups, the basic preoperative preparation included bed rest, sedation by means of sodium bromide, a high caloric diet, calcium gluconate grains 15 t.i.d., large doses of vitamins A, B_1 or B complex, C, and D, as well as Lugol's solution minims 10–15 t.i.d. In one of the estrogen treated cases iodine administration was delayed until not later than six days preoperatively, while in other cases of the estrogen treated group institution of iodine therapy antedated the administration of estrogenic substances.

TABLE I

SUMMARY OF DOSES OF ESTROGEN

Showing variations in type of estrogen used, dosage and response as shown by pulse and basal metabolic rates on admission, after basic therapy, and preoperatively following estrogen administration

Case No.	Total Dose	Dose Schedule	Response a—on admission; b—after basic therapy; c—following estrogen	
			Pulse	B.M.R.
1.	12,000 u. theelin	2,000 u. daily for 6 days preceding operation	a—125	a—81
			b—120	b—47
			c—105	c—46
2.	100,000 u. theelin	10,000 u. daily on 12 days preceding operation (2 days omitted)	a—110	a—27
			b—110	b—29
			c—110	c—25
3.	10,000 u. theelin	One dose on day preceding operation	a—135	a—73
			b—120	b—42
			c—90	c—35
4.	20,000 u. theelin	10,000 u. daily on 2 days preceding operation	a—110	a—78
	4 mg. diethylstilbestrol	24 hours preoperatively	b—115	b—58
			c—127	c—55
5.	30,000 u. theelin	10,000 u. daily for 3 days preceding operation	a—107	a—37
			b—115	
			c—90	c—8
6.	60,000 u. theelin	10,000 u. daily on 15th, 16th, 17th, 18th, 19th, 20th day prior to operation	a—90	a—24
			b—82	
	16 mg. diethylstilbestrol	4 mg. t.i.d. on 7th, 8th, 9th, 10th day prior to operation	c—85	c—30
7.	250 mg. diethylstilbestrol	Given during the 15 days preceding operation	a—110	a—33
			b—115	b—33
			c—90	c—25
8.	218 mg. diethylstilbestrol	Given during 30 days prior to operation	a—90	a—60
			b—100	b—60
			c—85	c—30
9.	4 mg. diethylstilbestrol	1 mg. daily for 4 days prior to operation	a—140	a—58
			b—115	b—48
			c—95	c—44
10.	20,000 u. theelin	10,000 u. on each of 8th and 9th days prior to operation	a—105	a—31
			b—105	b—31
	56 mg. diethylstilbestrol	Given during the 9 days preceding operation	c—105	c—11
11.	242 mg. diethylstilbestrol	Given during 30 days preceding operation	a—110	a—33
			b—130	b—45
			c—90	c—27

The estrogens employed were either theelin in oil, administered intramuscularly, or diethylstilbestrol, administered orally. In several instances both of these preparations were employed in the same case.

All of the estrogen treated cases received intravenous pentothal sodium anesthesia immediately before being brought to the operating room. Three of the control group received pentothal sodium intravenously, and one received tribromethanol per rectum as a means of inducing basal narcosis. Ethylene and oxygen supplemented with ether were administered to five control cases and eight estrogen treated cases. Ethylene and oxygen was given to four of the control group. One of the control group received nitrous oxide and oxygen and one received cyclopropane and oxygen. Three of the estrogen treated group received cyclopropane and oxygen at the time of operation.

The dose schedule, as well as the total amount and type of estrogenic substance employed, varied considerably (Table I). The table also indicates the responses of the individual cases. It is noteworthy that only one case, after receiving 56 mg. of diethylstilbestrol, was nauseated and complained of itching. On account of the uncertainty of the effects of estrogens in hyperthyroid patients, small doses were first used. Later, larger doses were employed, and three cases received over 200 mg. of diethylstilbestrol by mouth. The possibility of refractoriness following repeated doses of estrogens has been discussed in a previous report.[2]

A comparison of the average changes in basal metabolic rates in response to basic treatment in the estrogen treated group, with the corresponding changes which occurred in the control group, is shown in Chart 2. An additional 10.9 per cent average lowering of basal metabolic rate in this group followed estrogen therapy (Chart 3).

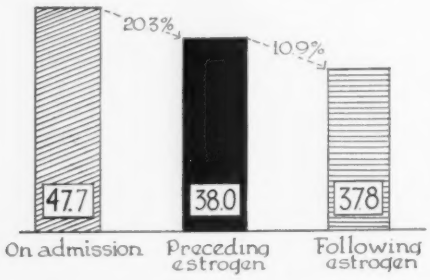


CHART 3.—Showing the additional lowering in basal metabolic rate which followed estrogen therapy in the group of cases which had shown refractoriness to basic treatment.

Comparison of the average changes in pulse rates, in response to treatment and operation, are shown in Graph 1. Following estrogen administration the average pulse rate reached a level as low as that attained in the control group. Although the peak pulse rate during operation in the initially more toxic group which received estrogen therapy was slightly higher than that of the control group, the lower average peak pulse rate on the first postoperative day in the estrogen treated cases is significant, and is in accord with the better subjective feeling and the general appearance at that time, of the estrogen treated patients. This observation is of particular significance because of the greater number of patients in this group who had one thyroid lobe still functioning after operation. Preoperative preparation in the control and estrogen treated groups averaged 25.6 days and 14.7 days, respectively.

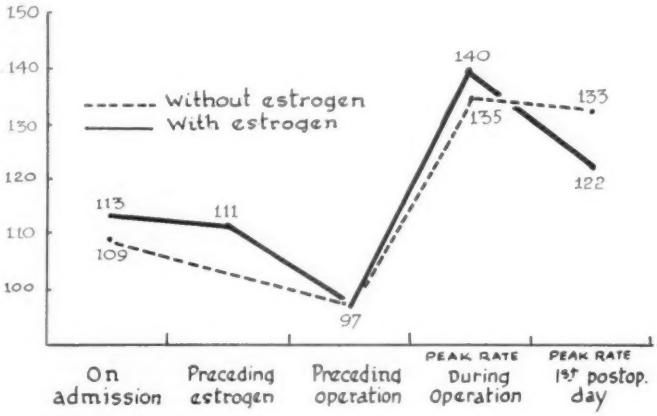
SUMMARY AND CONCLUSIONS

(1) The rationale for the employment of estrogen therapy in hyperthyroidism is discussed.

(2) Therapy with estrogenic substances was employed in 11 cases with hyperthryoidism having an average basal metabolic rate of +47.7 per cent, four of which were iodine-fast and four of which manifested such toxicity as to be considered to require multiple-stage operations.

(3) The response to preoperative treatment and operation of the estrogen treated cases is compared with corresponding observations made in 11 cases of hyperthyroidism in which estrogenic therapy was not employed.

(4) The patients who received estrogen therapy consistently looked and felt better than did the control group. This difference was most pronounced during the immediate postoperative period.



GRAPH 1.—Showing comparison of average pulse rates on admission following basic treatment, following estrogen, the peak pulse rate during operation, and the peak pulse rate on the first postoperative day.

(5) An average preoperative lowering of pulse rate equal to that which occurred in the control group was observed in the estrogen treated cases, even though more of the cases which received estrogen therapy were iodine-fast at the time of admission.

(6) The average peak pulse rate of the first postoperative day in the cases which received estrogen therapy was lower than was the average peak pulse rate on the same day in the control group.

(7) No crises occurred in the estrogen treated group, and there has been no opportunity to observe the possible effects of estrogen administration in the presence of this complication, but it is suggested that estrogen therapy may be of value both for the prevention and treatment of thyroid crisis, especially following a first-stage lobectomy.

(8) Although no definite conclusions can be drawn concerning a relation between dosage and effect, comparison of the presently reported observations with those following smaller average doses,[1] suggest that small doses of estrogenic substances are equally as effective as large doses, if not more so. Reference is made to the possibility of refractoriness to estrogen therapy following repeated doses. From observations made so far, it appears that

estrogen therapy is most effective when administered for from four to seven days preceding operation when subtotal thyroidectomy is undertaken in one stage. When multiple-stage thyroidectomy is performed, it seems advisable to continue estrogen therapy for several days following the first stage, and, especially if there is a lapse of more than a week between operations, to reinstitute estrogen therapy preceding the second stage.

(9) The present observations imply that estrogen therapy is valuable only as an adjunct in the surgical treatment of hyperthyroidism. So far, no significant difference has been observed in the response to estrogen therapy by patients with toxic diffuse goiters compared with those with toxic nodular goiters.

(10) The number of cases in which estrogen therapy has been employed is too small for the results to be statistically significant. Individual variations, and variations in the timing and amount of estrogen therapy prohibit extrapolation of the present findings. From the observations so far made and herein reported, it is believed that employment of this form of collateral therapy is warranted, especially in (a) severe cases of hyperthyroidism, and particularly when the severity of the disease is of such degree that multiple-stage procedures are necessary; and (b) in iodine fast cases.

(11) No conclusions can be drawn concerning the relative values of theelin and diethylstilbestrol as estrogenic substances suitable for use in hyperthyroidism.

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DISCUSSION.—DR. HUGH H. TROUT (Roanoke, Va.): I have had absolutely no experience with these estrogens, but we have had plenty of experience with bromides in mental cases, which I thought might be interesting.

We had two hyperthyroid cases which were mentally upset, with hallucinations and other signs which we thought at first were due to thyrotoxicosis, and we should be on the outlook for bromide retention. I do not know how many of you are familiar with the situation relative to the too free use of bromides. The taking of bromides has become an American habit, so much so that now very few patients are admitted to the State or Veterans' Hospitals for the mentally sick without a study of the blood bromides. It is very interesting that the bromides apparently remain fixed in the blood until released by the administration of normal saline. When this is done the mental symptoms usually disappear rather promptly. That is what happened in these two thyroid cases with mental symptoms until we used intravenous normal saline. In the other, the mental symptoms disappeared before operation after the intravenous use of normal saline. I think it is a very serious condition that our State and Veterans' Hospitals for the mentally sick have so large a proportion of patients who have this history of having taken bromides. It might be advisable for us, as surgeons, to have preoperative study made of blood bromides in our surgical cases with mental symptoms.

INTESTINAL ANTISEPSIS WITH SULFONAMIDES*

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IN DECEMBER, 1940, a preliminary account of the use of sulfanilylguanidine in the preparation of the colon for surgical procedures was given before the Southern Surgical Association.[1] No conclusions were drawn from the 12 case records that were presented. It was emphasized that the report was to be looked upon as an initial step in a far-reaching study. It seemed clear that we had found a new application for chemotherapeutic substances; namely, the elimination of pathogenic bacteria from the alimentary canal before surgical procedures are attempted. Our clinical experiences with sulfanilylguanidine grew rapidly, and it soon became apparent that this drug was far from satisfactory. We found that it is often ineffective in the presence of ulcerative lesions; that in many instances the drug has to be given in large amounts at four-hour intervals to bring about a significant reduction in the bacterial count in the stool; and also that sulfanilylguanidine has little or no effect upon certain pathogenic bacteria within the bowel. Furthermore, from experimental and clinical studies it was shown that the original claim that sulfanilylguanidine is poorly absorbed from the gastro-intestinal tract is incorrect.[2] The drug is readily absorbed from the small intestine, and the low concentration found in the blood is due to rapid elimination of it by the kidneys. For this reason sulfanilylguanidine should not be given to any patient having intestinal obstruction or impaired renal function. These observations, together with a report of the occurrence of mild toxic reactions, were presented in April, 1941, before the American Surgical Association,[3] and led us to abandon the use of sulfanilylguanidine and to commence a systematic search for a compound of high antibacterial potency, low toxicity, and poor absorbability from the gastro-intestinal tract. The successful completion of this effort is largely due to the skill of E. J. Poth, who laid the foundation for the experimental work by constructing an apparatus for accurately feeding dogs a fixed amount of drug at regular intervals. We were able to test, simultaneously, many compounds. At least three sulfonamides were found that have the desired properties. One of these, succinyl sulfathiazole,† has been extensively studied on experimental animals and on 120 patients.[4]

When succinyl sulfathiazole is given by mouth in adequate amounts, and at proper intervals, one notices that the contents of the gastro-intestinal tract are altered. The stools become soft and odorless and the amount of flatus

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

† As far as the author can find out, succinyl sulfathiazole was first synthesized by Dr. Melvin Moore, of the Sharp and Dohme Laboratories.

is diminished. These changes reflect the alterations that take place in the bacterial flora. We have found that certain organisms are particularly susceptible to succinyl sulfathiazole, whereas others are unaffected by it. In the former group are *B. coli, B. dysenteriae* (Shiga, Flexner and Sonne), and in the latter group are *B. typhosus, alpha Streptococcus fecalis,* and *B. proteus.* In order for succinyl sulfathiazole to exert an antibacterial effect in the alimentary canal it is necessary for the drug to get into contact with the mucosa.

Ulcerative lesions retard but do not destroy its efficiency. A blind loop which is inaccessible to the drug will prevent a fall in bacterial count in the stool. Similarly, severe constipation or an active diarrhea interferes with the antibacterial action of the drug. The fresh stool of animals which have been given succinyl sulfathiazole for several days will contain from 50 to 200 mg. of free sulfathiazole. Upon standing at 37° C. the proportion of this compound to succinyl sulfathiazole rises rapidly, thus indicating that the latter is progressively hydrolyzed to form free sulfathiazole.

We have given succinyl sulfathiazole to more than 120 patients in the Johns Hopkins Hospital and the Union Memorial Hospital, in Baltimore. As judged by changes in the number of coliform bacteria in the stool, it can be said that in almost every instance the ingestion of adequate amounts of this compound lowered the concentration of *B. coli* to less than 1,000 per gram of wet stool. Frequently there were fewer than 100 of these organisms per gram of stool. The only exceptions to these results have been in two patients with blind loops, two with intractable diarrhea, and one child with chronic intestinal indigestion. In two patients having large ulcerated carcinomata of the colon the administration of the drug had to be stopped because of an alarming hemorrhage. In all of the 120 patients succinyl sulfathiazole was poorly absorbed in the alimentary canal, even in those with impending intestinal obstruction. The concentrations of succinyl sulfathiazole and sulfathiazole in the blood of the patients at the Johns Hopkins Hospital were regularly determined and found to average less than 2 mg. per cent. The average urinary excretion was 4.85 per cent of the total amount of drug given by mouth. Since this compound has a free carboxyl group, it forms salts easily and, consequently, can be excreted in the urine in high concentration. In none of the patients studied has there been fever, rash, nausea or vomiting attributable to the drug. In all of the patients having large bowel resections there has been primary healing despite the opening of the bowel at the time of the anastomosis.

The usual daily dose of succinyl sulfathiazole is 0.25 Gm. per Kg. of body weight. It is preferable to give this in six portions; that is, at four-hour intervals. It is important to omit cathartics, especially mineral oil, when using this compound. In patients with severe diarrhea the dose is double the ordinary one. The drug should be given for a period of from 5 to 7 days before operating on the colon and should be continued for 10 days postoperatively when anastomoses have been performed.

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DISCUSSION: DR. EDGAR J. POTH (Baltimore, Md.): I should like to take this opportunity to thank you for extending me an invitation to attend this meeting and for the privilege of discussing this paper. Also, I want to express my appreciation to Doctor Firor for his detailed presentation of those phases of this investigation with which I have been concerned.

A study of some 30 sulfonamides with dibasic acid substitutions on the primary para-amino group has uncovered several compounds showing strong bacteriostatic action locally in the bowel. Many of these drugs, however, are highly toxic. Of the substances studied, succinyl sulfathiazole has the best therapeutic ratio. The concentration of any of these compounds in the blood is not necessarily a true index of the toxicity, because the kidney threshold might be low and the drug be rapidly excreted, or the compound might be excreted readily by the liver into the bile to be returned to the gastro-intestinal tract. The toxicity of any one drug is probably linked with the total quantity of drug actually disposed of by the tissue cells of the body.

That the chemotherapeutic properties of succinyl sulfathiazole are influenced by the free carboxyl group of the substituting side-chain is indicated by the extent to which the drug is excreted in the bile. An accurate analytic method for the determination of this substance in bile is not available, but crude analytic procedures indicate that considerable quantities of the drug are excreted by the liver. Furthermore, the concentration of the drug and the bacteriostatic response in the feces of animals receiving the compound parenterally show that considerable quantities of the substance are being excreted into the bowel by way of the liver, pancreas, or intestinal mucosa.

The daily intravenous administration to dogs of 2 Gm. per Kg. of succinyl sulfathiazole causes no gross or microscopic cellular damage. The animals usually vomit once immediately following the injection. Shortly thereafter the animals eat and have no loss of appetite. There is excessive salivation.

In order that the effectiveness of succinyl sulfathiazole can be evaluated as a local bacteriostatic agent and as an adjuvant in colon surgery, this drug has ordinarily been administered alone. Obviously, it may be advantageous to saturate the general body tissues with another sulfonamide which is readily absorbed from the intestine and so fortify the local action of succinyl sulfathiazole as well as give added protection to surrounding tissues post-operatively. This plan has been followed in a few instances.

Quantitative bacteriologic studies have been confined to the coliform organisms, because (1) *B. coli* are constant inhabitants of the gastro-intestinal tract; (2) the coliform bacteria are moderately resistant to the action of the drug; and (3) the cultural characteristics of these organisms permit their quantitative estimation in the complex bacterial mixtures encountered in feces. The profound physical changes occurring in the stools following drug therapy indicate that the bacterial flora is greatly altered. *B. proteus, alpha Streptococcus fecalis,* and the *Salmonella* group of organisms are not affected. *B. aerobacter aerogenes,* while affected, is more resistant than *B. coli.* The

Shiga, Flexner and Sonne strains of the dysentery bacilli are highly susceptible to the action of the drug, as indicated by the results of treatment of some 20 cases of bacillary dysentery. All severe cases of the disease have been cured following four days of treatment. The administration of succinyl sulfathiazole to patients with typhoid fever did not seem to alter the clinical course of the specific disease. The distention was, however, relieved, and the usual bowel care and enemata were not required. One patient had perforations of the lower ileum. At operation, three perforations were closed, and cultures made of the contaminating intraperitoneal material failed to grow *B. coli,* whereas the typhoid bacillus was grown in pure culture in desoxycholate medium.

Dr. E. P. Lehman (Charlottesville, Va.): Through the courtesy of Doctor Firor, and the manufacturers, we have had this substance available for a few weeks, and have used it in a small group of patients with and without large bowel lesions. We have made a considerable number of observations on each patient. I would simply like to confirm the statements Doctor Firor has made. There was a very prompt and sometimes a complete drop in the count of coliform organisms in the stool. Also, the absorption, as judged by the urinary output, is relatively low, about 1 or 2 per cent of the amount ingested. The third thing we noted was that the blood levels have not been as high as Doctor Firor reported. With the small group of patients we have had, we have nothing to say about succinyl sulfathiazole as a clinical adjunct, but we are encouraged.

Dr. L. Wallace Frank (Louisville, Ky.): I am not going to make any attempt to discuss this paper, but would like to ask a question. I understood Doctor Firor to say that in cases of constipation, and especially in cases of obstructive lesions, the drug cannot, and does not, come in contact with the bowel and hence it is not efficacious. Has the drug been used as an irrigation through a cecostomy wound or through the rectum up to the point of colonic obstruction?

Dr. Warfield M. Firor (Baltimore, Md., closing): Doctor Frank's question I can answer in the affirmative. Any way you can get the drug into the bowel is satisfactory.

I might tell you a story, in conclusion. I received a letter from a former student about a month ago, who is now in another clinic. He said: "There is a lot of bad surgery here and I hold you directly responsible. The surgeons feel if they give some sulfaguanidine they can forget all about surgical technic, and they do forget about it, and it is your fault!"

URETERAL TRANSPLANTATION AND CYSTECTOMY*

COMPARISON OF RESULTS AFTER EIGHT YEARS

ADDISON G. BRENIZER, M.D.
CHARLOTTE, N. C.

COFFEY,[1] in 1909, before the Southern Surgical Association suggested the submucosal position of the ureter in the bowel to create a valve, in imitation of the course of the common bile duct between the muscular and mucous coats. This suggestion was executed by C. H. Mayo in February, 1912, and immediately began to supplant the former methods and modifications of Maydl, Moynihan, Martin, Stiles and Fowler, who were never able to create a satisfactory type of valve to protect the end of the ureter. Coffey[1] carried out three methods of disposing of the ureteral ends in the submucosal position: (1) The severed ureteral end, one at a time, was immediately transplanted through the mucous membrane into the bowel. (2) Both ureteral ends, armed with catheters, were simultaneously transplanted through the mucosa into the bowel. (3) The ureteral end was tied off, transfixed to the bowel wall, and penetrated by a necrosing suture into the bowel, to later cut through and create a lateral uretero-intestinal anastomosis.

The difficulties encountered by Coffey of passing the necrosing suture into the bowel lumen, a tight or loose suture, the passage of a rigid instrument to the left and past the valves of the human rectum and sigmoid were overcome by Brenizer's[2] ring and thread in a supple catheter or rectal tube.

This catheter holding the ring and string was passed up the rectum to the site of the necrosing suture, the suture was easily passed into the ring in the rectum, and when the suture was tied down on the ring it held the ureter and mucosae steadily in position. The cutting of the necrosing suture was aided by peristalsis and tugging on the thread and ring.

The first three cases were performed by the transplantation of the ureters, one at a time, by the necrosing suture, and Brenizer's ring and thread method.

The urograms in the last case in this series are pictured soon after transplantation of the ureters and cystectomy and again eight years later. The patient is in good health; has two bowel movements a day, none at night; the abdomen is well supported, but the ureters and pelves are considerably dilated (Figs. 1 and 2).

Cabot, Walters,[8] Ladd and Lanman,[9] and Lower[ ]performed an operation similar, but somewhat modified, and, certainly perfected over that of the original Coffey-Mayor procedure. Cabot performed the operation extraperitoneally, while Ladd and Lanman turn the anastomosis behind the peritoneum. Their results offer a formidable argument in favor of their operation. Walters has operated upon 26 cases, with one death, Cabot 20 cases without any mortality, and Ladd and Lanman 32 cases, without a death. Their recent communications with me (September, 1941) show their

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

remote results, which are remarkably free from urinary infections. However, some of their intravenous pyelograms show a dilatation of one ureter and pelvis or the other. Lanman believes this due to angulation or stricture of the ureter at the site of the anastomosis and says: "We feel confident that if the anastomosis is straight and unobstructed, there will be a minimum amount of kidney infection."

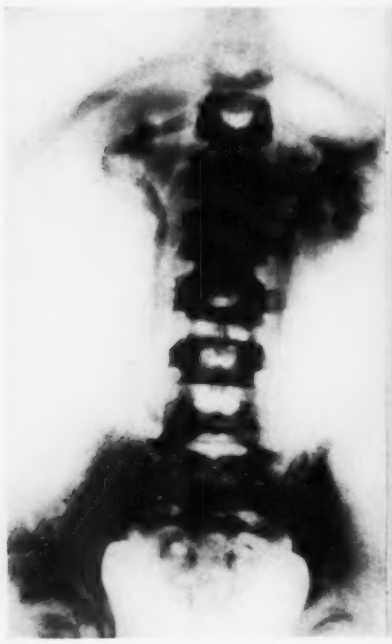

FIG. 1.—Urogram soon after the transplantation of the ureters by the necrosing suture method, creating a lateral ureterointestinal anastomosis.

FIG. 2.—The lateral anastomosis of the ureter in the bowel has certain disadvantages over the turning of the total caliber of the ureter into the intestine: obstruction is more apt to occur as evidenced by a dilatation of the ureters and pelves; admixture of intestinal contents and urine takes place at the site of the anastomosis and infection is conveyed to the bladder field; finally the ureteral stumps, from the site of the anastomosis to the bladder, must be found, tied off and tucked back into the bowel, when the cystectomy is performed.

Lanman and Colby[11] decry the use of catheters. Priestly formerly transplanted both ureters simultaneously, using short rubber catheters, but tells me now: "I did use them for a few years until I felt confident of the technical procedure, but now I am getting along quite satisfactorily without them." Ferguson,[3] in his experiments on cats, transplanted a segment of both ureters simultaneously into the rectum and left both ureters connected and running urine to the bladder. Higgins[4] employed Ferguson's suggestion and Coffey's necrosing stitch, caught through gauze wrapped around a rectal tube. Higgins reported to the writer 52 cases with three deaths and good functional results following his technic. Walters[8] objected to the necrosing suture, as elaborated by Higgins, saying: "In an experimental

study of the so-called aseptic suture necrosis method, Mann and I found that immediate or eventual hydronephrosis occurred so frequently, even though urine appeared in the rectum from the fourth to sixth day in most cases, that I have been fearful to use the method clinically."

The writer could not, so summarily, dismiss the suture necrosis method as did Walters, and employed the simultaneous transplantation of both inact ureters with his ring and thread. There was repeated pyelitis in a colored girl who had undergone a simultaneous transplantation of a segment of both ureters, using the necrosing suture and the Brenizer ring and thread (Ferguson, Higgins, Brenizer). The writer does say, and agrees with Walters and Mann thus far, that operations upon the ureter which do not eventually turn the total caliber of the ureters into the intestine, but depend upon a lateral ureterointestinal anastomosis, may be followed by partial obstruction at the site of the implant. In addition to this, the flow of urine is not immediately cut off from the bladder and there is an interchange between the lumina of the ureter and intestine, contaminating the urine to the bladder. Also when cystectomy is performed, the ureteral stumps, from the anastomosis to the bladder, must be found and tucked back into the bowel. In spite of these disadvantages, the great majority of these cases, where the necrosing suture was used, have ended well in spite of some dilatation of the ureters and pelves (Figs. 1 and 2; repeated pyelitis in the colored girl).

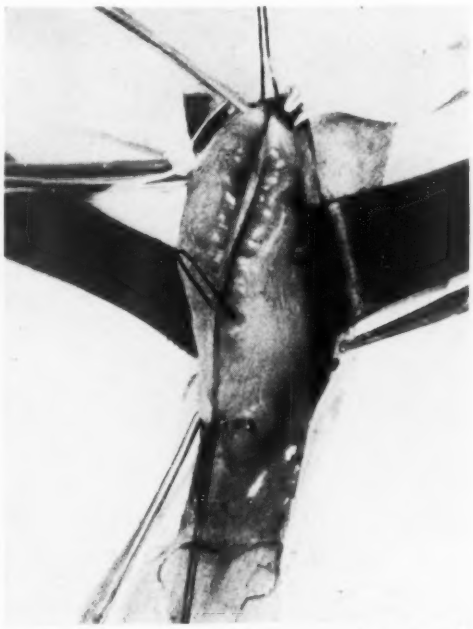

FIG. 3.—A segment of both ureters is implanted, simultaneously, into the rectum at one abdominal operation. Each ureter is looped over by a long hairpin wire, sharpened on the ends. The ends are made to pierce the mucosa and pass down a catheter, previously inserted into the rectum, until a narrow loop straddling and surrounding the ureter remains. The catheter-wire arrangement is left in the rectum for eight days, when the ureter is cut and its total caliber turned into the rectum by the application of an electro-cutting current to the wire ends, where they emerge from the catheters at the anus.

The fact it was along the route of the necrosing suture that the writer[5, 6] developed the following method: A segment of both ureters, left connected and running urine to the bladder, was placed in the submucosal position. The ureter was straddled by a hairpin wire, the sharpened ends of which were passed through the intestinal mucosa into a catheter previously inserted into the rectum (Fig. 3). And then the muscularis and serosa were closed over the ureter and wire loop. After about eight days, the ureters were cut

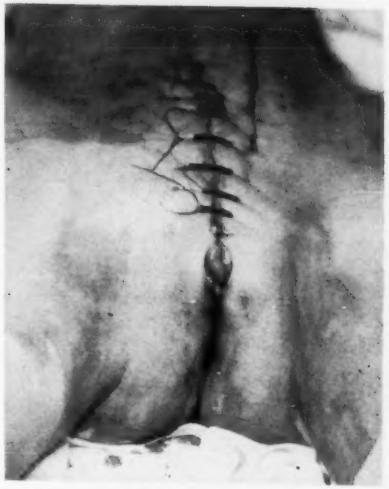

FIG. 4.—With both ureteral ends completely turned into the rectum and all urine flow cut off from the bladder, the ureteral stumps to the bladder may be disregarded and the cystectomy made easy. The wide dissection in a sterile field allows a better plastic closure.

FIG. 5.—Urogram of the case in Figure 4 before operation shows a marked hydroureter and hydronephrosis.

FIG. 6.—The urogram of the case in Figure 4 shows the ureters and pelves not more dilated but decidedly improved with time.

through and completely turned into the gut by applying an electro-cutting current to the wire ends emerging from the catheter at the anus.

An operation similar to the original Coffey-Mayo procedure as performed by Walters, Ladd and Lanman, and Lower, and that by Brenizer,[5, 6] have two very essential points in common. Both of them, eventually, turn the total caliber of the ureter into the bowel and divert all urine from the bladder.

FIG. 7.—Boy, 17 years, 8 years after transplantation of the ureters and cystectomy for epispadias and incompetent vesical sphincters and repair of the epispadias. At the time of the cystectomy, the seminal vesicles and vasa deferentia were preserved and a rim of bladder was sewn over the prostatic urethra. Due to this vescical pouch, ejaculation and viable spermatazoa have been retained.

FIG. 8.—The urogram of the ureters and pelves, 8 years following the operations, shows them to be normal in structure and function. The patient is in good health, has two or three bowel movements a day and he has retained his sexual and procreating functions.

(1) The Brenizer[6] procedure accomplishes this at one operation. All hemorrhage, edema and lameness of the ureter and bowel which might obstruct, are allowed to subside before the ureter is cut through with an electro-cutting current.

(2) The wound is never exposed to infection by opening the mucosa or piercing it toward the abdomen by a transfixing suture. The ends of the hairpin wire pass from the abdomen through the mucosa into the rectum.

(3) The anastomosis is turned behind the peritoneum. In reality, the incision in the intestine is made to approach and loosely envelop the ureter,

scarcely raised from its bed. The ureter is lifted but not stripped of its blood and nerve supply. With the looser fit of the intestinal mucosa around the ureter, the two structures, by moving up and down or by rotating, can adapt themselves more in line with each other. The stitching of the peritoneal incision to the bowel finally gives it anchorage.

The immediate and ultimate results in the two following cases (Figs. 4, 5, 6, 7, and 8), pictured after transplantation of the ureters and cystectomy and then again after eight years, shows them in good health, a couple of bowel movements daily and the intravenous urograms improved, rather than grown worse with time.

At the time the cystectomy was performed on the boy, the vasa deferentia and seminal vesicles were separated from the bladder and a rim of bladder was used to cover the prostate. To the creation of this pouch around the prostate by the writer and the repair of the epispadias, undertaken by Dr. R. W. McKay, of Charlotte, is attributed his power of erection, ejaculation and viable spermatozoa. This boy is in excellent health. His urogram is normal after eight years, and he has retained his sexual and procreative functions.

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FINNEY-HOWELL RESEARCH FOUNDATION, INC.

At the meeting of the Board of Directors of this Foundation held in February, eight fellowships were awarded for the period of one year. A list of the eight Fellows follows:

Julius C. Abels, B.S., M.D., to work at Memorial Hospital for the Treatment of Cancer and Allied Diseases, 444 East 68th St., New York City.

Glenn Horner Algire, M.D., to work at the National Cancer Institute, Bethesda, Md.

Bernerd E. Kline, B.S., M.S., to work at McArdle Memorial Laboratory, University of Wisconsin, Madison, Wis.

Margaret Nast Lewis, A.B., Ph.D., to work at the Crocker Radiation Laboratory, University of California, Berkeley, Calif.

Alfred Marshak, B.S., Ph.D., to work at Crocker Radiation Laboratory, University of California, Berkeley, Calif.

Rose I. Shukoff, M.D., to work at the Glasgow Royal Cancer Hospital, Glasgow, Scotland.

Emilia Vicari, to work at the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

Benjamin Norman Horwitt, B.S., Ph.D., to work at Harvard University, Converse Memorial Laboratory, Cambridge, Mass.

THE TREATMENT OF TRICHOMONAS VAGINALIS VAGINITIS WITH THE LACTOBACILLUS*

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AND

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IT IS with some hesitation that we present another method of treating vaginitis due to trichomonads. Time and further clinical studies have shown, in the case of so many of the methods already advocated, that the claims made for them were unwarranted.

Some one has truly said that a trichomonas infection is an ideal condition to treat in transients. By this it is meant that when an out-of-town patient consults a physician because of an irritating discharge caused by trichomonads he can usually give prompt temporary relief and acquire her gratitude. The trouble is that so often the symptoms return with the next or subsequent menstrual periods.

The return of symptoms with menstruation is due probably to the decreased acidity of the vagina which occurs at this time. In many instances a few trichomonads survive the prescribed treatment and continue to live in the upper vagina, and with the decrease in acidity they increase in number, set up an inflammation, and cause a return of the vaginal discharge.

The importance of these recurring exacerbations of trichomonas vaginalis vaginitis cannot be overemphasized, for in women during menstrual life the trichomonas vaginalis is probably the commonest cause of leukorrhea. There is, in our minds, not the slightest doubt that this statement is true when one is referring to the type of women seen in private practice and, we believe, it is also true for dispensary patients, although gonorrheal endocervicitis in this latter type of patient runs the trichomonas a close second as a cause of leukorrhea. Moreover, the trichomonads must always be thought of and looked for when a woman complains of pruritus and dyspareunia.

Trichomonads cause a vaginitis and little, if any, endocervicitis. The characteristic lesion is most often seen in the upper posterior part of the vagina just behind the cervix. One not infrequently sees in this area minute red spots, giving the upper posterior vaginal wall a strawberry-like appearance.

Some of those who have written about trichomonas infections have stated that the discharge often contains bubbles and is apt to have a slight greenish tint but personally we have seldom observed these peculiarities in the discharge. In our experience there is nothing that is characteristic in the appearance of the discharge. It may be thick or thin, yellow or white. It is, however, apt to cause much more irritation than does the discharge caused by endocervicitis.

* Read before the Southern Surgical Association, Pinehurst, N. C., December 9–11, 1941.

The trichomonads occasionally invade the urethra, Skene's and Bartholin's glands. Cases of salpingitis, due to the trichomonas vaginalis, have been reported but, although we have seen many hundreds of patients with a leukorrheal discharge due to these organisms, we have never seen a case of salpingitis for which we thought they were responsible.

The trichomonas is a protozoa with actively moving flagella at one extremity and an undulating membrane. The latter cannot always be seen as easily as the flagella. These organisms are larger than an ordinary pus cell and yet smaller than the epithelial cells which line the vagina and which can always be seen in vaginal smears. The trichomonads are very motile. Under the microscope their flagella can be seen moving rapidly. When the protozoa happen to be caught under a mass of epithelial cells they often make the whole clump of cells move.

The diagnosis is made by demonstrating the organisms with the microscope. No special apparatus is needed. All that is required is a little normal salt solution and an ordinary microscopic slide. In some articles you will read that hollow ground slides should be used in studying the trichomonas but they are not necessary. The technic for demonstrating these organisms is as follows: The gloved finger is inserted high in the vagina behind the cervix and a drop of the secretion taken on the gloved finger. This is mixed with a little normal salt solution and the preparation examined at once. The organisms can be seen under low or high grade power. It is not necessary to stain them.

In some women, smears examined in the intermenstrual period may fail to show the organisms, while those taken immediately before or after a period will reveal them. In fact, in some instances the organisms can more easily be demonstrated if the patient is examined when she is actually menstruating.

The diagnosis is often missed for two reasons. The first is the same reason that explains why so many conditions remain undiagnosed. It is that they are not thought of. The second reason that explains why physicians sometimes fail to make the diagnosis is that while they think of trichomonas vaginalis as a possible cause of leukorrhea they think of it two minutes too late. That is what often happens. A woman comes to a doctor complaining of a leukorrheal discharge. He thinks of endocervicitis, polyps, carcinoma and many other gynecologic conditions as being the possible cause of the discharge. He at once puts green-soap or some other lubricant on his fingers and makes a pelvic examination. After his examination has failed to demonstrate any of the conditions mentioned above he then thinks of the possibility of a vaginitis due to the trichomonas vaginalis, takes smears, looks at the material under the microscope and fails to see the organisms. This may be due to the fact that the green-soap on his fingers killed the trichomonas which were in the superficial tissues and by which the diagnosis could have been made. We feel that it is advisable to take smears for trichomonas vaginalis as the first step in the study of all patients complaining of leukorrhea, pruritus, and dyspareunia.

Another factor that sometimes interferes with the diagnosis of trichomonas

infections and also of gonorrhea is that many women through a natural sense of cleanliness will take a douche immediately before coming to a doctor's office and thus prevent the physician from making the diagnosis. It is well to ask every woman who comes to you complaining of leukorrhea when she took her last douche.

Until we began working on the method of treatment which we are now presenting, we had, as most of us have, tried one after another of the usual procedures recommended for trichomonas vaginalis vaginitis. All of them were helpful in some cases. However, as has been the experience of so many gynecologists there were numerous cases in which a recurrence of symptoms occurred following the menstrual periods with a reappearance of the protozoa. Moreover, there were a few patients to whom the treatments did not give even temporary relief.

Although there have been many treatments recommended for trichomonas vaginalis vaginitis, they may be divided into two groups based on what it is hoped the treatment will accomplish. In the first, an effort is made to destroy all the protozoa by the use of antiseptics. Silver picrate, aldarsone and carbarsone are among those that have been recommended. Sometimes mechanical cleansing with green-soap or other solutions is added to the use of antiseptics.

In the second group of treatments less attention is paid to antiseptics than to measures which it is hoped will restore the normal defenses of the vagina. They are based on the general idea that it is possible for the protozoa to exist only when the normal mechanism which protects the vagina against infection has been disturbed.

In general, this defense mechanism of the vagina is believed to depend primarily on three conditions. First, that the vaginal secretion remains at its normal low p_H; second, that the Döderlein or vaginal Lactobacilli are present in sufficient numbers to form lactic acid and finally that there is sufficient carbohydrate, perhaps in the form of glycogen, in the vaginal epithelial cells or spaces between the cells to afford adequate nourishment for the continued growth and activity of the Döderlein bacilli.

With the idea that in vaginitis acid douches might restore the bactericidal power of the vagina, lactic acid and vinegar douches have been prescribed in trichomonas vaginalis. They do give the patient considerable relief but apparently are not sufficient, in themselves, to completely correct the condition. Few if any cures have been brought about by simply using acid douches.

Adair and Hesseltine believe that, in the treatment of trichomonas vaginalis vaginitis, the most important therapeutic measure is to furnish sufficient nourishment to maintain a normal bacterial flora and, hence, they recommended, in 1936, that vaginal tablets containing 95 per cent lactose and 5 per cent citric acid be used. Karnaky with the same idea became enthusiastic over the use of vaginal suppositories, containing lactose and dextrose. The preparation which Karnaky recommended, and which was placed on the market under the trade name of floraquin, does also contain an antiseptic

known as diodoquin but the antiseptic is thought to have less therapeutic value than the sugars.

We have used floraquin in a large number of cases, with some satisfactory results. However, there were in the series of patients quite a few who continued to harbor the parasites in the vagina and to have recurrences of leukorrhea and pruritus with the menstrual periods. Being rather discouraged by the results obtained from the numerous preparations that had been recommended for the treatment of vaginitis due to the trichomonas vaginalis we decided to attempt to build up the vaginal defense by simultaneously carrying out several measures. Not only was nourishment suitable for the growth of Döderlein's bacillus to be introduced into the vagina but also viable Lactobacilli.

Such a procedure if feasible seemed worth trying. To quote from Hesseltine on an article dealing with trichomonas infestations: "One thing is well established and that is with the restoration of the vagina to a normal cellular and bacteriologic flora the disease entity vanishes."

Since the time when Metchnikoff proposed the ingestion of Lactobacillus bulgaricus as an an "elixir of life" to the more recent work of Rettger and many others, aciduric bacteria have enjoyed periodic popularity as agents for the relief of certain human ailments. Within the last two decades, "acidophilus therapy" has soared and fallen. It was used principally for the relief of gastrointestinal symptoms and depended upon implantation of the organisms in the intestinal tract with subsequent elimination of other, less desirable, types of bacteria. The literature from 1910 to 1930 contained a great deal of evidence that such therapy was justified. On the other hand, its popularity as a panacea has been rightfully questioned. When indicated, massive doses have doubtless given desirable results. It is not our purpose to take issue with either view in the discussion which arose in this respect. There can be no doubt that many commercial preparations during the heyday of acidophilus therapy were of little or of no value due to the lack of viable Lactobacilli.

Perhaps, however, some of the unfavorable reports, such as those by Bass and James, on Lactobacillus preparations were in part due to media difficulties for, as will be brought out shortly, we had in the beginning of this work considerable trouble in growing Lactobacilli on the usual solid medias. Moreover, James, in a recent personal communication, has expressed the opinion that conditions in the intestinal tract and in the vagina are so different it is not surprising that we have been successful in implanting Lactobacilli in the vagina.

Our first attempts to treat trichomonas vaginalis vaginitis with lactic acid-forming bacilli plus sufficient carbohydrate for the nourishment of the bacilli were rather crude. The junior author, who at the time this work was started, was the Bacteriologist to the Gynecological Department of the Johns Hopkins Hospital, had a culture of Lactobacillus which had been obtained from the United States Department of Agriculture. The culture secured from Washington is known as Hansen's strain, and has been used throughout this investi-

gation. Two lumps of ordinary sugar were coated with this culture and placed in the vagina. Quite naturally the heat of the tissues soon melted the sugar, converting it into syrup which ran out of the vagina. Tampons made of ordinary cotton were of no help as they quickly absorbed the syrup and prevented its coming in contact with the vaginal epithelium. Tampons made of nonabsorbent cotten were then used, with more success. In fact, many women obtained prompt relief by this crude treatment.

Encouraged by these results we then endeavored to work out a simpler method of carrying out this treatment. Tablets were then prepared for us under the careful supervision of Dr. John Brewer, Bacteriologist for Hynson, Westcott and Dunning. The tablets are prepared in the following manner:

Sterile skim milk is inoculated with a culture of Lactobacillus bulgaricus, U.S.D.A. Hansen's strain. After 48 hours' incubation, 1,000 cc. of this culture is mixed with 325 grams each of XXXX sugar and milk sugar. This is thoroughly dissolved in the milk and the mixture is spread in thin layers on enamel pans and dried in a vacuum oven at 37° C.

The mixture is scraped from the pans, broken into bits, and replaced in a drier to complete desiccation. When completely dried six cubic centimeters of white mineral oil and 38 Gm. of starch are added. The mixture is then pressed into tablets. The finished tablets weigh 1.3 Gm., and represent 1.25 cc. of original culture.

We were, of course, interested in determining the number of live Lactobacilli to the tablet. Tomato juice agar, using the formula of Valley and Herter, and also dehydrated tomato juice agar (Difco) was not found to be satisfactory for this purpose. On the other hand, it was possible to prove the presence of viable organisms in milk and tablets when dilutions were made in tubes of litmus-milk and later in thioglycolate medium. By this method we were able to determine the number of living organisms in a tablet or in one cubic centimeter of the milk culture. Dilutions were made by placing one tablet into 10 cc. sterile water. One cubic centimeter of this, when dissolved, was transferred to a tube containing nine cubic centimeters of sterile water, one cubic centimeter of this dilution transferred to a second tube containing nine cubic centimeters, and so on. One cubic centimeter of each dilution was transferred to 10 cc. of thioglycolate medium or litmus-milk, making the final dilution from the first tube, one tablet per 100; second tube, one tablet per 1,000, etc. Growth of the Lactobacilli was determined by coagulation of the milk or clouding of the thioglycolate medium, and Gram's stain of these media after 24 hours' incubation showing presence of typical gram-positive bacilli.

By this procedure we have determined the approximate number of viable Lactobacilli in tablets kept for as long as 12 months. Numerous samples taken from different lots of tablets all showed between 10,000 and 100,000 viable Lactobacilli in each tablet after they had been stored in a refrigerator for 12 months.

It is of interest, and possibly important, to note that in no case were contaminating organisms found in or on any tablets tested, in spite of the fact

that no precautions were taken, during storage, to maintain sterility. This, of course, may be explained on the basis of the acidity of the original milk cultures used in making the tablets.

These tablets have been used in several different ways, and it may be that the best way has not yet been worked out. However, the method which we are employing at present is the following: As soon as the diagnosis is made a bivalve speculum is introduced into the vagina, the cervix inspected for complicating endocervicitis and Skene's and Bartholin's glands inspected for possible involvement. The vagina is then dried with cotton and two Lactobacillus tablets inserted high in the vagina in the posterior fornix behind the cervix. The vaginal orifice is then plugged with a tampon of nonabsorbent cotton. When the patient returns on the next day the tampon is removed, material taken from the vagina for microscopic study and the treatment carried out on the preceding day repeated. On this second visit practically every patient will report that the itching has been much less, and it is very unusual to be able to demonstrate organisms at this time.

Such office treatments are repeated daily for from four to six days. The patient is then told to insert one Lactobacillus tablet high in the vagina each night. She is told to take douches only if she becomes uncomfortable from unabsorbed particles of the tablets coming out of the vagina and causing irritation. A white vinegar douche (5 per cent acetic acid) is recommended in a strength of from two to four tablespoonfuls to two quarts of water. Two douches a week are usually sufficient.

This home treatment is continued from three to six weeks and longer if necessary. However, if the organisms promptly disappear and show no immediate tendency to recur, the tablets need be used only every other night. It is especially important that they be used while the patient is menstruating, as that is, of course, the time when the vaginal defenses against the trichomonads are weakest.

If there is an endocervicitis which in itself is producing some of the leukorrhea it is treated by a cauterization. All patients are given the usual instructions regarding toilet technic, just as should be given no matter what method of treatment is being carried out. This consists of instructing the patient to clean herself, after defecation, from in front backwards, that is from the vagina towards the rectum, rather than in the reverse manner as is usual in most women. This lessens the likelihood of the condition being kept up by constant reinfection from the anus. When it is possible to clear up the infection quickly it is better to advise against sexual relations. When the treatment must be continued for a longer period of time the patient is instructed to take a plain water douche before coitus.

Unfortunately, some dispensary patients cannot come for daily office treatments during the first week after the diagnosis has been made, and in these cases we have to rely largely on the home treatments carried out by the patients themselves. We have not given patients tampons of nonabsorbent

cotton with which they themselves might plug the vaginal orifice, although this might be advisable.

These tablets have now been used on 50 consecutive, unselected cases. Thirty-one were white women, 19 colored. There were two children in the series, age six and seven, respectively, and two women beyond the menopause. The remaining 46 were in the reproductive age.

Just a few days ago a five-weeks-old child was brought into the dispensary with a profuse leukorrheal discharge which was thought to be gonorrheal in origin. However, smears for gonococci were negative while examinations for trichomonads showed a large number of the protozoa. Because the vagina was so small we have had difficulty in getting the Lactobacilli into it. However, we have been fairly successful with some long, very narrow tablets. Perhaps suppositories would be more effective, but their preparation has not yet been completed. After two treatments the discharge almost entirely disappeared, although there are a few organisms still present. This is, I believe, one of the youngest cases of vaginitis due to the trichomonas vaginalis which has been recorded. It is of interest that the mother also has a vaginitis due to the trichomonas vaginalis, indicating that the child probably acquired the disease from the mother.

All 50 of the women in our series complained of a vaginal discharge, 40 of pruritus vulvae and ten of dyspareunia. Fifteen had received treatment for the trichomonas infestation before coming under our care. Thirty-seven had had symptoms for over six months before we saw them, and 25 for a year or more. In our series there were only four patients whose symptoms were only a few weeks' duration.

This paper is essentially a report of the results obtained by the use of tablets containing Lactobacilli and not a detailed clinical study of vaginitis due to the trichomonas vaginalis. However, we wish to state that on the basis of our observations we are in complete accord with those investigators who in the past few years have brought out the fact that trichomonads not infrequently cause an inflammation of the Bartholin glands. This is a point of sufficient importance to deserve being stressed. Until a few years ago many gynecologists taught that when an examination showed bilateral thickening of the Bartholin glands one could be almost certain that at some time the woman had had gonorrhea. This is incorrect. Shelanski and Savitz, in 1939, reported that they had demonstrated trichomonads in Bartholin's and Skene's glands, and proved conclusively that an inflammation of these glands may be due to trichomonads. In our series there were several cases of bartholinitis, in all probability due to the trichomonas vaginalis. In one patient, an unmarried woman with a hymen which would not admit the tip of the finger, the glands reached the size of olives. One case in our series interested us especially. Trichomonads were persistently present in the voided specimen of urine, while smears taken from the walls of the vagina showed no protozoa. After several examinations the trichomonads were found to be coming from an infected Skene's duct.

We realize that a series of 50 cases is not large enough to draw any very definite conclusions from regarding the efficacy of a method of treatment. Nevertheless, we do feel that our results warrant this preliminary report of the work we are doing.

Every patient treated with the Lactobacillus tablets showed immediate improvement and in many instances the organisms disappeared at once. Nevertheless treatment was continued from three to six weeks and when necessary longer. There have been recurrences in six patients whom we had thought were cured, perhaps in some instances these were reinfestations. Usually the supposed recurrence cleared up more rapidly than did the first infestation.

Forty-eight out of the series now have negative smears, and are asymptomatic. Both of the patients with positive smears are women in whom recurrences or reinfestations recently developed. They are now being treated.

All the patients whom we have considered cured have been instructed to report for examination immediately at the termination of each menstrual period, and without taking a douche before coming for examination. Thirty-five patients have remained symptom-free and have shown persistently negative smears for three months. We have 20 patients who are apparently well after six months.

We are enthusiastic about the prompt results which we have obtained with the Lactobacillus tablets, and we have had numerous patients go without treatment for from three to six months in order to prove that they have really been cured of the infestation. Nevertheless, we feel that every woman who has had a trichomonas infection should continue for considerable time to take either acetic acid douches or to use the Lactobacillus tablets for a few days each month around the time of the menstrual period. In fact, no matter what treatment is carried out for vaginitis due to the trichomonas vaginalis it should, in our opinion, be repeated at each menstrual period for from six months to a year.

There is still a great deal to learn about the trichomonads. Perhaps what we need is not a more effective way of treating this condition but to learn the necessity of treating it for a longer period of time than we have in the past. It is possible that the organisms, when attacked by various antiseptics, develop a few very resistant forms with the power to live much longer than the ordinary trichomonads.

There are of course certain questions that at once present themselves when one considers the advisability of using lactic acid-forming bacilli in vaginitis and some of these we hope to answer in the near future. For instance while we have clinical results to report which indicate the effectiveness of the method which we have used, and are also able to prove that the tablets themselves contained great numbers of viable lactic acid-forming bacilli, even when refrigerated 12 months, we have not shown just how rapidly these tablets restore the vaginal flora to its normal state.

We have analyzed the bacteriologic flora of a series of women, and

selected six from whose vagina it was impossible to grow any Lactobacilli. These six were instructed to insert one Lactobacillus tablet in the vagina every night for six nights and then to report for examination 48 hours later. Five of these six were then shown by culture to have large numbers of viable Lactobacilli in the vagina.

SUMMARY

A method of treating vaginitis due to the trichomonas vaginalis is presented. It differs from other methods in that viable lactic acid-forming bacilli are introduced into the vagina. There have been a few recurrences or reinfestations, but in all cases the method has yielded almost immediate relief of symptoms and in the great majority of instances the vaginas have remained free of trichomonads. Many of these patients have now been followed for six months.

We realize that much additional clinical and laboratory work must be carried out to establish, definitely, the value of Lactobacillus therapy in the treatment of vaginitis due to the trichomonas vaginalis. In spite of the relatively good results which we have obtained we do not claim that this method of treatment will completely eliminate recurrences in all patients. However, we feel our results justify this preliminary report.

The authors wish to express their appreciation to the Hynson, Westcott and Dunning Co. for their cooperation in this work.

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ACOUSTIC TUMORS

WITH SPECIAL REFERENCE TO END-RESULTS AND SPARING OF THE FACIAL NERVE

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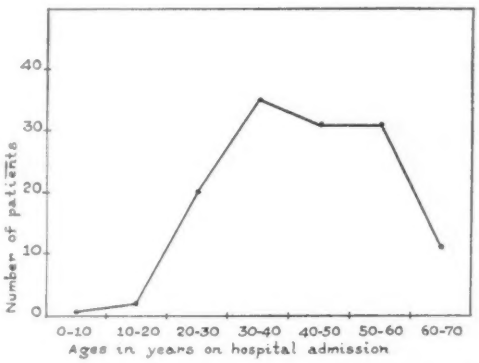
IN A RECENT PRELIMINARY REPORT on acoustic tumors, Olivecrona[1] stated: "The problems have shifted insofar as we are now not so much concerned with the immediate mortality, which has been reduced to reasonable proportions, but with the late results." With this in mind, the purpose of the present study is to give the late results in Olivecrona's entire series of acoustic tumors from 1930 to 1939. In addition, a detailed description of the operative technic of saving the facial nerve during radical removal of these tumors is presented, together with certain further points of diagnostic and clinical interest.

The material consists of 130 cases of verified acoustic tumors, operated upon between June, 1930 and June, 1939. In every instance microscopic examination of the growth proved it to be a neurinoma. An additional number of 34 cases of acoustic tumor, previously verified by operation, and reported by Olivecrona in 1934,[2] will not be considered in the present study except in the discussion of mortality statistics where the material then published is carried up to date. Finally, it may be mentioned that three cases of bilateral acoustic tumor, also not here included, were previously verified by operation, and two of these were reported by Olivecrona in 1928.[3]



Graph 1.—Representing the ages on admission, plotted by decades.

Age.—Graph 1 represents the ages on admission, plotted by decades. It may be seen that the greatest number of patients came under observation during the age-period of 30 to 40 years. The youngest patient was 18 years of age, and the oldest 68. The average age of the 130 patients is 42.3 years. It is interesting to note that in Doctor Cushing's series of 190 neurinomata the average age is approximately the same, that is, 40 years.*

Sex.—There were 79 females (60.8 per cent) and 51 males (39.2 per cent). This incidence of approximately 60:40 among the sexes in Doctor Olivecrona's series is also close to that in Doctor Cushing's series of 190 neurinomata, in which the corresponding figures are 122 females (64.2 per

* Personal communication from Dr. Louise Eisenhardt, Brain Tumor Registry, Yale University School of Medicine, New Haven, Conn.

cent) and 68 males (35.8 per cent).* Another interesting point, to which attention has already been called, is the possible significance of the fact that there is the same definite predominance in the incidence of meningiomata in females over males, the proportion being 60:40 in a series of 313 cases.[4]

Symptoms and Signs.—The chronology of symptoms and signs in cases of acoustic neurinoma, as established by Cushing,[5] is as follows:

(1) Auditory and vestibular disturbances.
(2) Occipitofrontal headache with suboccipital discomfort.
(3) Incoordination and instability.
(4) Evidence of involvement of adjacent cranial nerves.
(5) Signs of increased intracranial pressure with choked disks.
(6) Dysarthria and dysphagia.
(7) Cerebellar crises and respiratory difficulties.

FIG. 1.—Case 7:37: Showing patient two years and five months after complete extirpation of neurinoma, with preservation of the facial nerve.

To-day, these progressive, characteristic symptoms and signs are so well recognized in the average case of acoustic neurinoma that they need not be considered in further detail here.

Occasionally, however, in a somewhat atypical case, the diagnosis may be obscure, and ventriculography becomes necessary. This occurred in four instances in the present series, one of which may be briefly described as follows:

Case No. 240:37—Admission of female, age 29, complaining of moderate headache of five years' duration. For four years there had been diminished hearing, bilaterally, with tinnitus in the right ear. For two years vision had been failing, advancing to blindness on the left. For two weeks there had been slight clumsiness of left hand.

Examination showed bilateral choked disks, with blindness on left and markedly lowered vision on right. There was no nystagmus. Hearing was markedly diminished, bilaterally, and there was slightly diminished caloric reaction on the right. No definite cerebellar disturbances were present. Roentgenologic examinations of the internal acoustic poruses were negative.

The preoperative diagnosis was uncertain, partly because the deafness was bilateral and the adjacent cranial nerves were uninvolved, and partly because of a poor history due to language difficulties. *Tentative Diagnosis:* Pinealoma or intraventricular meningioma.

Only by ventriculographic study was the lesion disclosed. Dr. E. Lysholm's report is as follows: "There is evidence of a high degree of pressure, with symmetrically internal hydrocephalus including the third ventricle. The fourth ventricle is slightly dislocated dorsally and somewhat to the left. There is a filling defect on the right side of the fourth ventricle. Roentgenologic examination shows the picture usually seen in cerebellopontine angle tumor."

At operation both cerebellopontine angles were investigated, but tumor was found to be present on the right side only.

FIG. 2.—Case 240:37: Photographs taken 18 months after complete extirpation of tumor, with preservation of the facial nerve.

FIG. 3.—Case 240:38: Patient 14 months after complete removal of neurinoma, with preservation of the facial nerve.

Another deviation from the usual chronologic, progressive syndrome of acoustic neurinoma is represented by those cases in which normal or nearly normal hearing and normal caloric responses are present. There are several such examples in the present series. In these cases one of the divisions of the eighth nerve (vestibular) is usually uninvolved and occasionally even both divisions are found to be intact. Thus in Case No. 478:37 it is specifically mentioned in the clinical record that vestibular function was intact and hearing normal, bilaterally, although at times the patient had experienced noises in one ear. Unfortunately the weight of this tumor was not recorded, but the fact that bilateral choked disks were present indicates that the growth was large enough to cause obstruction to the flow of cerebrospinal fluid.

Smaller asymptomatic acoustic neurinomata have been reported in the literature. In an examination of serial sections of the temporal bone in 250 unselected cases, Hardy and Crowe[6] found, in five instances, a typical acoustic neurinoma deep in the internal auditory canal. These tumors were too small to cause clinical symptoms.

It may be of interest at this point to note which cranial nerves were found to be involved by the neurinomata in this series. They are listed in order of frequency of involvement as follows:

ORDER OF FREQUENCY OF CRANIAL NERVES INVOLVED

Nerves Involved	No. of Cases	Per Cent
1. Acoustic (cochlear division)	129	99.2
2. Acoustic (vestibular division)	118	90.8
3. Trigeminal	92	70.8
4. Optic (diminished vision)	72	55.4
5. Facial	71	54.6
6. Abducens	16	12.3
7. Glossopharyngeal and vagus	7	5.4

The rarity of glossopharyngeal involvement is remarkable considering the intimate relation of acoustic tumors to this nerve. However, it may be pointed out that patients are not aware of loss of function of the ninth nerve, a fact we often have had opportunity to verify in cases in which this nerve had been severed for relief of glossopharyngeal neuralgia.

Although, subjectively, the patients themselves are unaware of any loss of function following section of the glossopharyngeal nerve, objectively, anesthetic areas are to be found homolaterally in the tonsillar fossa, pillars and uvula. That clinical records often fail to mention any sensory loss in cases in which the ninth nerve has been severed may be due to the difficulties in detecting such loss. Most authors agree that sensory changes occur and that motor function remains unaltered.

Another important point is the presence or absence of nystagmus. In this series of 130 cases nystagmus was present in 125 cases, or 96.2 per cent. It is generally agreed that nystagmus may result from a lesion involving the cortico-cerebellar pathways. Since the corticocerebellar fibers pass from the cortex to the cerebellum by way of the middle cerebellar peduncle, it seems reasonable to assume that absence of nystagmus is a favorable sign, indicating that there is little, if any, compression of the brain stem. Other fibers in the brain stem which give rise, if injured, to nystagmus are the cortico-oculomotor fibers after leaving the Deiters' nucleus as well as the ascending fibers of the posterior longitudinal bundle.[7] Here again, absence of nystagmus may mean that these fibers have been spared and, consequently, a tumor causing no nystagmus may be considered to be a more favorable one.

In the present series brain stem compression as evidenced by choked disks was present in 90.8 per cent and, as mentioned above, nystagmus was present in 96.2 per cent. A few cases showed neither nystagmus nor choked disks. This further strengthens the probability that nystagmus and brain stem compression may be related phenomena—the latter responsible for the former. However, an occasional case will show no nystagmus in the presence of frank choking of disks, indicating that other factors than brain stem compression probably play a rôle in the production of the type of nystagmus observed in cases of acoustic neurinoma.

Roentgenologic Diagnosis.—An examination of the porus acusticus internus to detect possible enlargement from pressure atrophy was made in all of the 130 cases. It was found that some degree of enlargement together with a rather typical funnel-shaped appearance, with or without destruction of the pyramid, was present in 106 cases, or 81.5 per cent. In four cases, one of which has been briefly described above, ventriculographic studies were made because the history and the neurologic findings were atypical. In each of these four cases the diagnosis of a cerebellopontine angle tumor was made chiefly on the basis of the roentgenologic findings.

Operative Technic.—With only three or four exceptions all of the operations in this series of 130 cases were performed by Doctor Olivecrona. In 75 cases there was complete extirpation of the tumor with its capsule. In 27

cases the extirpation was subtotal. In 28 cases an intracapsular enucleation of the tumor mass was done. The definition of these different types of operations for acoustic neurinomata, as carried out by Olivecrona, may be stated as follows:

(1) *Complete Extirpation:* An operation with total removal of all macroscopically visible tumor.

(2) *Subtotal Extirpation:* An operation in which radical removal had been attempted but found impossible to carry out, usually because of technical difficulties due to a very friable capsule and comparatively firm adhesions to the pons.

(3) *Intracapsular Enucleation:* An operation which is deliberately incomplete.

As seen above, by far the greatest number of cases have been treated by *complete removal* of the tumor, with its capsule, the operative technic of which is as follows:

Operative Technic.—The patient is placed horizontally, with the face down, on the operating table, to which are attached special shoulder- and head-rests.

Local anesthesia, preceded by luminal and morphine in small amounts, is the method of choice. This is particularly to be desired because the operator then can follow the fate of the facial nerve during the entire operative procedure, a matter of great importance, as will be discussed later. The pain elicited from the cranial nerves to which a tumor may be attached may be abated or entirely avoided by placing pledgets of cotton moistened with 2 per cent procaine solution on the respective nerves, especially the trigeminus.

Unilateral exposure of the cerebellar hemisphere, as advocated by Dandy[8] in 1934, retaining a narrow bony rim at the foramen magnum, suffices. A resection of the lateral third of the cerebellar hemisphere has been found unnecessary, good exposure usually being obtained by means of de Martel's self-retaining retractor combined with rotation of the operating table about an horizontal axis in the proper direction. As a rule, the ventricular pressure is diminished by puncture of a posterior horn of the lateral ventricle, the needle being left in place during the entire operation. The dura is then opened, the posterior or medullocerebellar cistern, if present, is emptied, and following the opening of the lateral pontine cistern, the tumor is exposed. A small area of the exposed surface of the tumor is coagulated, and the mass of tumor within its capsule removed with spoon and suction, as in the usual intracapsular enucleation.

In Olivecrona's own words the complete extirpation is now carried out as follows:

"It is essential to push the process of intracapsular enucleation as far as possible in order to obtain ample room for the maneuvers that follow. To safeguard against perforation of the capsule on the ventral side and possible injury to the facial nerve, it is customary to have a nurse observe the face of the patient at frequent intervals. If the operator gets too near the nerve, twitching of the face occurs and further removal of tumor in this particular region should then be abandoned.

"The first step in the removal of the capsule is the mobilization of its lower pole. The glossopharyngeal, vagus and accessory nerves are gently stripped from the lower pole, to which they are sometimes slightly adherent. The nerves are always elongated and dislocated by the tumor, and it is a matter of surprise that functional loss in the region of these nerves is rarely observed.

"An important blood vessel running to the tumor is often seen between or ventral to the above-mentioned nerves. This little artery is a branch of the vertebral and should be doubly clipped and cut.

"While the cerebellum is being held aside by de Martel's automatic spatula, the operator now pushes the lower pole upwards by means of a narrow brain spatula, and a search for the facial nerve is begun. The nerve is most easily found near its emergence from the brain stem, and it is usually possible to recognize it as a flattened band of nerve tissue running alongside the brain stem for a few millimeters before it disappears below the ventral surface of the tumor. When the nerve is seen, its identity is confirmed by faradic stimulation. While the patient's face is under constant observation the nerve is gently mobilized from the ventral surface of the tumor. This is easily done until one reaches a point about half way between the brain stem and the porus, where rather firm adhesions between the facial nerve and tumor capsule are often encountered. It may also be difficult to keep the nerve in full view at this point, and it may be necessary to reduce the bulk of the tumor by further intracapsular manipulations. The course of the facial nerve is rather variable: In most cases it runs fairly straight on the ventral surface of the tumor between the emergence from the brain stem and the porus; in other cases it may be pushed so far in an anterior direction as to be more on the anterior than on the ventral surface of the tumor. In such instances it enters the porus at the anterior margin instead of the usual point of entrance at the posterior, inferior margin. If the facial nerve disappears from view it is usually advisable to mobilize the tumor from the porus so that the nerve may be identified at its point of entrance into the porus.

"The neoplastic tissue present in the porus can usually, after firm adhesions present alongside the superior margin of the porus have been separated by sharp dissection, be cleanly enucleated from the porus by a blunt instrument, such as a dissector. On the ventral side the facial nerve is separated from the capsule of the tumor by a thin sheath of arachnoid, the presence of which makes it possible to mobilize the lateral stalk of the tumor from the porus without injury to the facial nerve. If the nerve is not seen at its point of entrance into the porus it can easily be localized by means of faradic stimulation. The nerve is then dissected free from the capsule from outwards inwards until the nerve is completely free from the capsule in its entire course. The removal of the capsule should not be attempted until the dissection of the facial nerve is complete, otherwise the nerve is usually torn at some point where it is adherent to the capsule.

"The last adhesions between the tumor and the porus are now separated. The petrous vein, which is always encountered along the superior, anterior margin of the porus, is clipped or coagulated and divided. The trigeminal nerve is separated from the tumor by the same layer of arachnoid that separates the capsule of the tumor from the facial nerve. Adhesions between the capsule and the trigeminal nerve are rarely encountered and usually the nerve can be stripped from the capsule without difficulty.

"All important nerves now being out of the way, the capsule may be removed. This should, whenever possible, be undertaken from outside inwards, *i.e.*, the lateral stalk of the tumor is grasped with a broad-bladed forceps and gently pulled in dorsal and medial directions. Between the emergence of the fifth and the eighth nerves from the brain stem the tumor is usually more or less embedded in the pons. While pulling at the tumor the pons is gently stripped from the surface of the tumor, and the vessels coming from the basilar artery are clipped and divided as they are encountered. If the capsule is reasonably tough this procedure is usually carried out with ease and without injury to the brain stem, and the whole of the capsule comes away in one piece. Sometimes, however, the capsule is very friable and breaks when the operator tries to pull on it. In such cases it is usually necessary to remove the capsule in numerous small fragments. Even this may be impossible on account of firm adhesions between the brain stem and the tumor. As a last resort a broad brain spatula is inserted between the tumor and the cerebellum and an attempt made to dislocate the tumor from within outwards. This must be done with the greatest care in order not to damage the brain stem, and the attempt should be abandoned if too firm adhesions are encountered. However, with increasing experience it has been found possible to remove the tumor in practically every instance where a radical operation was indicated."

"Following removal of the tumor there is surprisingly little bleeding in the cavity, and what hemorrhage there is usually comes from veins on the lateral surface of the pons. Occasionally one or two bleeding points must be sealed with the cautery, but as a rule a few minutes' packing with pledgets wet in hydrogen peroxide is all that is necessary to insure complete hemostasis. The dura is then carefully closed and the wound sewed up in layers in the usual manner.

"The same technic, as just described, was employed in the cases of subtotal removal, with the exception that fragments of the tumor were left behind attached to the pons.

"The technic of intracapsular enucleation is carried out as described above up to the point where the tumor is exposed; then the capsule must be mobilized from the cerebellum as far as possible. It can be pulled out from its bed in the cerebellum a good deal, after gradual removal of its contents by suction curettage. In this way the upper pole is gradually dislodged sufficiently out of the incisura tentorii to reestablish the fluid pathways, which is very important. The curetting can also be done much more completely because of better visibility. In the olden days the tumor was left entirely in place and a very large part usually remained alongside the pons and most of the upper pole."

COMMENT.—In almost all cases of acoustic neurinoma one or the other of the three types of operation described above is carried out. However, occasionally a cystic neurinoma is encountered and here a radical procedure becomes unnecessary, for it suffices to empty the cyst, remove tumor fragments which are present in the cyst wall, and cauterize the cavity with Zenker's solution or some other agent. As far as we know, cystic neurinomata have no tendency to recur, a fact that has been observed in following up three patients operated upon by this less radical method prior to June, 1930, all still symptom-free in June, 1939.

The choice of operative procedure depends also on a number of other factors, such as age, sex, physical and mental health, and social position of the patient. From a technical standpoint it must be kept in mind that secondary operations are more hazardous than primary ones, since the presence of scar tissue entails greater danger to the pons and, in addition, renders the saving of the facial nerve well-nigh impossible. Consequently, the postoperative course may become more complicated and the morbidity increased. An attempt at radical removal, therefore, should be made in all cases except those in which the tumor is cystic or the patient's life expectancy is short, due to old age, social conditions, hypertension, or other systemic illness. Such an attempt does not mean that the facial nerve is necessarily endangered, because the decision as to whether or not to proceed radically is not made until the lower pole has been mobilized and the stalk divided at the internal acoustic porus, *i.e.*, before any harm has been done to the facial nerve. If technical difficulties make it impossible easily to preserve the facial nerve, and its preservation is imperative because of the individual or social aspects of the case, then a bridge of tumor tissue covering the facial nerve from the porus to the pons is left behind, all other visible tumor being removed. This type of incomplete operation was recently carried out in an elderly male with hypertension. Further discussion of the preservation of the facial nerve will follow later.

Table I shows the frequency of the three types of operation in different years expressed in percentages.

TABLE I

TYPES OF OPERATIVE PROCEDURES AND THEIR RELATIVE FREQUENCY

Year	No. of Cases	Intracapsular Enucleations*	Subtotal Extirpations	Complete Extirpations
1930–1931	10	80.0%	0.0%	20.0%
1932–1933	36	16.7%	16.7%	66.6%
1934–1935	31	6.5%	29.0%	64.5%
1936–1937	28	32.1%	21.4%	46.5%
1938–1939	25	12.0%	24.0%	64.0%

* No intracapsular enucleation was done in 1939.

Table I indicates that, except during the first two years, the radical approach with complete extirpation was the favorite one in this clinic.

Postoperative Course.—The postoperative course of the patients presented no unusual features. It may be mentioned, however, that in one instance (Case 244:38) a postoperative hemorrhage occurred. It so happened that in this particular case the facial nerve, which was severed during the operation, had been sutured. Subsequent reopening, with evacuation of blood clot, resulted in new tearing of the sutured facial nerve and complete facial paralysis ensued. In no other case was the facial nerve sutured in the posterior fossa, and it was unfortunate that the postoperative hemorrhage thus prevented the study of the effectiveness of reunion of the facial nerve. However, it seems reasonable to assume that, barring accidents, such as mentioned above, the suture should have resulted in complete restoration of facial function, particularly when one takes into consideration the recent thorough work of Tarlow,[9] who states that the transitional glial zone of the seventh nerve extends less than 1 Mm. beyond the exit from the pons, or 0.8 Mm., to be exact.

End-Results.—The statistical material on end-results is based upon answers to a questionnaire sent to all surviving patients in May, 1939. A prompt reply was received from 82.3 per cent of the patients. In practically all of the remaining cases the records of the end-results were obtained from letters received within the preceding two months or through personal interview. A few patients residing in distant parts were not heard from within this period.

The questionnaire covered essential points relating to cerebellar disturbances, such as difficulty in walking, involvement of the cranial nerves, particularly of the facial, muscular weaknesses, and, above all, the earning capacity of the patient. In 39.2 per cent of the cases the patients cooperated to the extent of sending photographs of themselves to show the present state of facial nerve involvement.

List,[10] in a paper on acoustic tumors, has divided his material into four groups, each group representing a certain developmental stage of the disease. In our series most of the cases happen to fall in the fairly advanced group described by List as Stage III, since the roentgenologic examination showed changes at the internal acoustic porus in 81.5 per cent, and choked disks were

present in 90.8 per cent of the 130 cases. It has seemed more desirable, therefore, in the present study to divide the material into three groups according to the particular operative procedure employed. The end-results in each group will be discussed, with emphasis placed upon the following: (1) Mortality; (2) facial paralysis; and (3) earning capacity.

FIG. 4.—Case 482:38: Showing patient 10 months after a complete extirpation, with preservation of the facial nerve.

(1) *Mortality.*—The total number of operations was 133 in the 130 cases. In Case 297:31 an intracapsular enucleation preceded a complete extirpation, and in Case 2518:35 two subtotal operations had been carried out before the tumor was finally removed radically. The results are shown in Table II.

TABLE II

MORTALITY STATISTICS IN 130 CASES OF ACOUSTIC NEURINOMA

	No. of Cases	No. of Operations	Operative Mortality	Case Mortality	Late Mortality
Complete extirpation.....	75	75	(14) 18.7%	(14) 18.7%	(4) 6.6%
Subtotal extirpation.....	27	29	(6) 20.1%	(6) 22.2%	(1) 4.8%
Intracapsular enucleation....	28	29	(8) 27.6%	(8) 28.6%	(4) 20.0%

The higher operative mortality percentage among the intracapsular enucleations may be explained by the fact that this procedure was most often undertaken during the early years of the clinic (*cf.* Table I).

At this point it may be of interest to refer to the mortality statistics of the first 34 cases of intracapsular enucleation, as reported by Olivecrona, at the Third International Neurological Congress, in Copenhagen, in 1939 (Table III). These cases, as has been pointed out, are not included in the present series.

TABLE III

MORTALITY STATISTICS IN 34 CASES OF INTRACAPSULAR ENUCLEATION OPERATED UPON PRIOR TO 1930

	No. of Cases	Operative Mortality	Died Later of Recurrence	Av. Survival-Period of Patients who Died Later	Av. Survival-Period of Patients Still Alive
Status in 1934.....	34	(9) 27.7%	(12) 48%	3½ yrs.	5 yrs.
Status in 1939.....	34	(9) 27.7%	(14) 56%	3¾ yrs.	10 yrs.

The immediate mortality in the two series of intracapsular operations (Tables II and III) is the same. In the second series of 28 intracapsular

operations (Table II) there were four late deaths, *i.e.*, a 20 per cent mortality among the survivors. That is apparently a much better result than in the first series (Table III) in which the corresponding figure was 48 per cent mortality among the survivors five years after the initial operation, and 56 per cent ten years after. However, if we exclude in the second series (Table II) the patients operated upon in 1937 and 1938, it becomes obvious that the low late mortality is due to dilution of the material with the more recent cases, as shown in Table IV.

TABLE IV

MORTALITY STATISTICS IN 21 CASES OF INTRACAPSULAR ENUCLEATION OPERATED UPON BETWEEN 1930 AND 1937

No. of Cases	Operative Mortality	Late Mortality
21	(7) 33%	(4) 28%

By excluding the recent cases the late mortality is increased from 20 per cent (Table II) to 28 per cent (Table IV), and it seems reasonable to anticipate an ever higher late mortality percentage as time goes on. Thus, in another five years, the difference between the late mortality, as given in Table II, and that represented in Table III, may decrease.

The *subtotal operations* show much better results and, even if the 1937 and 1938 cases are similarly excluded, the late mortality percentage is still fairly low (Table V).

TABLE V

MORTALITY STATISTICS IN 15 CASES OF SUBTOTAL EXTIRPATIONS OPERATED UPON BETWEEN 1930 AND 1937

No. of Cases	Operative Mortality	Late Mortality
15	(4) 27%	(1) 9%

In the group of *complete extirpations* the possibility of a recurrence is so slight that the time element need hardly be considered. This is borne out by the fact that even though the late mortality in this group is four, or 6.6 per cent, in only one case, or 1.6 per cent, could death possibly be attributed to a recurrence, though it hardly seems likely, as evidenced by the following autopsy report from the pathological Institute in Uppsala. Unfortunately the brain alone was examined.

Case No. 1058:34.—A tumor, the size of a large pea, was seen compressing the floor of the fourth ventricle and lateral aspect of the medulla oblongata. Histologically, the tumor has the appearance of a young neurinoma. At the site of operation a large area of old softening with glial scar tissue is seen. Except for senile involutions no other pathologic changes were noted. (Doctor Gellerstedt)

The other three patients died from the following causes:

(1) Cancer of the stomach, one and one-half years following the operation. No evidence of recurrence of acoustic tumor to time of death.
(2) Parotitis, septicemia, and psychosis, four years after the operation.
(3) Old age (74), six years after operation. No definite evidence of recurrence.

In the subtotal and intracapsular groups the late mortality was, in every instance, caused by recurrence of the tumor as far as could be determined.

In Table VI are given the deaths from recurrence with the average survival-period for each type of operation.

TABLE VI

NUMBER OF DEATHS FROM RECURRENCES IN THE THREE TYPES OF OPERATIONS

	Intracapsular Enucleations	Subtotal Extirpations	Complete Extirpations
Death from recurrences	(4) 20%	(1) 4.8%	?(1) 1.6%
Average survival-period in late deaths among recurrences	4¼ yrs.	4 yrs.	6 yrs.

The development in technical skill in performing complete extirpations, through the years, may be demonstrated by Table VII, in which the cases have been divided arbitrarily into groups of *circa* 19 each. A mortality of 11 per cent during the last two years indicated in Table VII shows the present trend, and, in the opinion of Olivecrona, a mortality of even less than 10 per cent will, in all probability, be attained in the future. In this connection it may be mentioned that no fatality has occurred among the last 16 cases operated upon with complete extirpation of the tumor.

TABLE VII

MORTALITY STATISTICS IN COMPLETE EXTIRPATIONS IN TWO-YEAR INTERVALS

	Year	No. of Cases	Operative Mortality	Case Mortality	Died Later
Group I	1931–1933	1–19 (incl.)	26.3%	26.3%	1
Group II	1933–1935	20–38 (incl.)	21.1%	21.1%	1
Group III	1935–1937	39–57 (incl.)	21.1%	21.1%	2
Group IV	1937–1939	58–75 (incl.)	11.1%	11.1%	0

THE FATE OF THE FACIAL NERVE

(2) *Facial Paralysis.*—The most common and obvious defect following radical removal of an acoustic tumor is a homolateral facial paralysis. This facial disfigurement, which at best can be only incompletely improved by the various plastic and anastomosing operations, is always a very unpleasant sequela to an otherwise successful operation, and may have very grave consequences for the individual. Careers have been ruined because of the presence of such a serious handicap. The hazards to which the facial nerve is exposed vary with the type of operation performed. In the *intracapsular* procedure there is much less danger of severing the nerve than in either of the two other procedures. As a matter of fact, with the present technic of having the patient's face constantly under observation during the operation, the operator always knows when he gets too near the nerve. If twitching of the face occurs, further removal of tumor in this particular region is abandoned. Thus the facial nerve may be saved in practically every instance.

In the *subtotal* procedure the facial nerve is identified in most cases after the lower pole of the tumor has been mobilized and the stalk cut at the porus, and with the recent improvement in technic it is hoped that severing of the facial nerve in this group will be the exception rather than the rule.

In the *complete* procedure the danger of cutting the facial nerve is greatest. Its identification is almost always possible during the operation, but whether or not the nerve can be saved depends on the skill of the operator and anatomic conditions plus some luck.

The first attempt in this clinic* to save the facial nerve in a case of complete extirpation was made on January 4, 1937. Since then there have been 23 complete extirpations (up to June, 1939), and the facial nerve has been saved, anatomically, in 15 instances (65.2 per cent). It should be noted that all the patients in whom the nerve was saved had a complete postoperative facial paralysis except one (Case No. 271:39). The paralysis gradually diminished, usually within three months to a year. Some of the results are shown in the following photographs of patients taken at various intervals after complete extirpation of the acoustic tumor. In some of the cases in which the facial nerve had been sacrificed a Lexer plastic operation was performed, but in the majority of cases an anastomosis between the facial and the accessory nerves was carried out. The latter procedure is definitely superior to the former and was performed in a total of 29 cases in the complete and subtotal groups, but never in the intracapsular group. The main effect of an anastomosis is abolition of atrophy of facial muscles and restoration of tonus. Facial movements are not restored but at least the eye can be closed by moving the shoulder.

FIG. 5.—Case 271:39: Patient three weeks after complete removal of neurinoma, with preservation of the facial nerve.

(3) *Earning Capacity.*—The ultimate aim of any operation is, of course, to return the patient to health and social usefulness. To what extent this aim has been fulfilled after each of the three types of operative procedure will be described.

First it may be stated that mere inability to obtain work has not been accepted as sufficient reason for placing the patient in the category "unable to work." The criterion used in determining a patient's inability to work has been the presence of infirmities such as poor vision, marked cerebellar disturbances, motor weakness, including that of the face, or any combination of these three, as well as total or nearly total invalidism.

The question of morbidity, then, as expressed in terms of capacity for work following each type of operation, is illustrated in Table VIII, in which,

* Previously, the facial nerve had been saved, but merely by chance, in two cases (Nos. 3278:35, 3235:33).

for the sake of completeness, the operative mortality as well as the number of late deaths are also shown.

TABLE VIII

MORTALITY AND MORBIDITY STATISTICS IN THE THREE TYPES OF OPERATIONS

	No. of Cases	No. of Operations	Operative Mortality	Case Mortality	Late Mortality	Full Earning Capacity	Earning Capacity Diminished	Unable to Work
Complete extirpations	75	75	18.7%	18.7%	6.6%	14.3%	66.1%	19.6%
Subtotal extirpations	27	29	20.1%	22.2%	4.8%	15.0%	70.0%	15.0%
Intracapsular enucleations	28	29	27.6%	28.6%	20.0%	37.5%	37.5%	25.0%

Table VIII demonstrates a fairly good showing in regard to morbidity in the intracapsular group. This is, however, largely due to the cases in which death has already occurred from recurrence. An additional factor is that some of the tumors are stationary in their growth. Doctor Olivecrona estimates that 10 to 20 per cent of acoustic neurinomata remain stationary, but, unfortunately, there is no way of telling beforehand, on pathologic grounds or otherwise, just which tumor will stop growing except when it is of the cystic variety. It appears reasonable to assume, then, that in the course of time in the intracapsular group only the patients with stationary tumors will remain alive, and that among the survivors most of the patients who were not already blind before operation will have full earning capacity.

In the groups of subtotal and complete extirpations the majority of the patients have some defect limiting their capacity for work. The commonest of these defects are poor vision, facial disfigurement, cerebellar disturbances, and general weakness; less common are keratitis, sensory disturbances of the face, including tic douloureux, which occurred postoperatively in two instances, hoarseness, which persisted for several years in one case, and an occasional example of mental disturbances.

In evaluating Table VIII the longer time necessary for convalescence and reeducation following a subtotal or complete extirpation should be borne in mind; reeducation may take even as long as two years. Also, Table VIII includes early cases, in which operation was performed at a time when the technic was comparatively crude, resulting in some instances in severe cerebellar disturbances, and in two cases in a more or less complete Wallenberg syndrome. The results of increasing experience in the technic of complete extirpation are given in Table IX.

TABLE IX

MORTALITY AND MORBIDITY STATISTICS IN COMPLETE EXTIRPATION, IN INTERVALS OF TWO YEARS

Year	No. of Cases	Case Mortality	Full Earning Capacity	Earning Capacity Diminished	Unable to Work
1931–1933	19	26.3%	7.7%	69.2%	23.1%
1933–1935	19	21.1%	14.3%	50.0%	35.7%
1935–1937	19	21.1%	21.4%	50.0%	28.6%
1937–1939	18	11.1%	6.3%	81.3%	12.4%

Table IX shows that during the years 1937–1939 only 12.4 per cent of the patients were completely unable to work, and this was due mainly to poor

vision, which was present prior to the operation. It is quite certain that a large number of the patients of the last two years, who at the present have diminished capacity for work, will regain, when their period of reeducation is over, full earning capacity.

In Table X a summary is given which includes a statement as to the patients' ability to walk, together with the percentage of blindness and clinical signs of recurrence. It shows that the majority of surviving patients have normal gait and station, in other words that cerebellar disturbances are not a major problem and of less significance than one might have expected.

TABLE X

A SUMMARY OF END-RESULTS IN THE THREE TYPES OF OPERATIONS

	No. of Cases	Case Mortality	Died Later	Full Earning Capacity	Earning Capacity Diminished	Unable to Work	Walks Normally	Walks with Stick	Unable to Walk	Blind	Clinical Signs of Recurrence
Complete extirpation	75	18.7%	6.6%	14.3%	66.1%	19.6%	54.4%	42.1%	3.5%	5.0%	0.0%
Subtotal extirpation	27	22.2%	4.8%	15.0%	70.0%	15.0%	65.0%	30.0%	5.0%	5.0%	10.0%
Intracapsular enucleation	28	28.6%	20.0%	37.5%	37.5%	25.0%	50.0%	37.5%	12.5%	10.0%	15.0%

Finally, it may be mentioned that List, in studying the capacity for work in Cushing's series of 125 followed-up survivors, found that 47, or 37.6 per cent, had full or diminished earning power. The corresponding figure in the present series of 103 followed-up survivors is 78, or 75.7 per cent, exclusive of the convalescent cases.

SUMMARY.—A survey has been made of 130 cases of acoustic neurinoma operated upon during the years 1930–1939. In addition, a detailed description is given of the operative technic for saving the facial nerve in cases of complete removal of the tumor. An analysis of end-results is included, with particular reference to mortality statistics, the fate of the facial nerve following operation, and the earning capacity of surviving patients.

CONCLUSIONS

(1) In this series of 130 cases of surgically verified acoustic neurinoma, the youngest patient was 18 years of age and the oldest 68. The average age of the entire group is 42.3 years.

(2) Seventy-nine, or 60.8 per cent, were females, 51, or 39.2 per cent, were males.

(3) The acoustic nerve was involved in 99.2 per cent of the cases, nystagmus was present in 96.2 per cent, choked disks were found in 90.8 per cent, and roentgenograms were positive in 81.5 per cent, as evidenced by changes at the internal acoustic meatus.

(4) Improved operative technic has lowered the mortality rate to 11.1 per cent in the group of complete extirpations during 1937–1939.

(5) Complete removal of the tumor is the operation of choice when dealing with an acoustic neurinoma because:

(a) Recurrences are rare.
(b) The danger of secondary hemorrhage is much less than in incomplete removal, and
(c) The presence of scar tissue in secondary operations increases the element of danger and makes saving of the facial nerve almost impossible.

(6) *Radical removal should be attempted in all cases* except in those in which the tumor is cystic or the saving of the facial nerve imperative.

(7) If the saving of the facial nerve is imperative an almost complete extirpation may still be possible by leaving a bridge of tumor tissue covering the facial nerve from the internal acoustic porus to the pons.

(8) The facial nerve may be saved in practically all cases of intracapsular enucleation. In the group of subtotal extirpation, improved technic has made saving of the facial nerve possible in the majority of instances. When complete extirpation was performed the facial nerve was spared in 15, or 65 per cent, of 23 cases operated upon during 1937–1939.

(9) The morbidity, *i.e.*, the degree of infirmity, as expressed in inability to work, has been lowered to 12.4 per cent in the group of complete extirpations during 1937–1939.

(10) Of the 103 survivors followed-up, 78, or 75.7 per cent, had full or diminished earning power, exclusive of the convalescent cases.

I wish to express my appreciation to Professor Olivecrona for the privilege of making this study.

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ABDUCENS NERVE (VI) PARALYSIS FOLLOWING SPINAL ANESTHESIA

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AT THE TURN of the present century spinal anesthesia became recognized as a well-accredited procedure with such men as Bier, Furster and Jonnesco, in Europe, and Babcock, in this country, as its staunchest supporters. Each one of these writers alluded to ocular palsies as a rare complication. Since this time, however, involvement of every one of the cranial nerves excepting the olfactory, glossopharyngeal and vagus has been reported as a postspinal complication. The abducens nerve is found to be affected in well over 90 per cent of all cranial nerve paralyses following lumbar anesthesia. Statistics, as presented by some authors, point to the incidence of paralysis of the abducens nerve as high as 1 per cent of all spinal anesthetics (Terrien[1]). Cantonnet[2] and François[3] speak of it as occurring once in every 250 cases. Why is it that during the past ten years only occasional cases are reported? It can be explained in any one of three ways: First, that our present technic and drugs have practically eradicated this rather disturbing complication; second, that these paralyses do occur but are not being recognized; and, third, that these cases do occur, are recognized, but are not being reported.

In 1906, Musham[4] and Landow[5] reported cases; and, in 1910, Reber,[6] in addition to his own five cases, reviewed the literature and found 36 cases at that time. It is surprising how little has been added insofar as the pathogenesis and therapy are concerned since the early authors presented their views during the first decade of the present century. Blatt,[7] in 1928, spoke of 87 cases, and during the same year, at the Surgical Congress in Paris, ten additional cases were reported, giving a total at that time of 97 cases in all. Since 1928, approximately 30 cases have been reported, with DiMarzi having the largest series, consisting of seven.

The etiology of abducens nerve paralysis is still not clearly understood. Numerous theories have been advanced by various men, with many arguments in favor of each. However, it appears that there are three general points to be considered in the pathogenesis, *viz.:* (1) Frequency of paralysis of the abducens over other cranial nerves. (2) Immediate etiologic factors. (3) The rôle played by preexisting diseases.

As stated above, over 90 per cent of all cranial nerve paralyses developing after a spinal anesthetic involve the abducens. This is probably due to the fact that the abducens nerve has a long course at the base of the skull, passing around the apex of the petrosal portion of the temporal bone. The long course of this nerve, its close relationship to a bony prominence, and the extreme narrowness of the foramen through which it has to pass, make

it extremely vulnerable to environmental changes. This may explain the frequency of paralysis of the abducens nerve in such conditions as meningitis, brain tumors, and diseases of the central nervous system.

The various immediate etiologic factors that may play a part in paralysis of the abducens nerve following spinal anesthesia are as follows:

(1) Mechanical:
  (a) Changes in pressure of the spinal fluid.
  (b) Changes in blood pressure.
(2) Toxic:
  (a) Local, direct.
  (b) Reflex.
  (c) General.
(3) Inflammatory.

Those who believe the theory of mechanical causation base their arguments on such points as the fact that paralysis of the abducens nerve has occurred following ordinary spinal puncture, with no introduction of any foreign material. It is well-known that the pressure of the spinal fluid changes following spinal anesthesia. DiMarzi believes that this complication occurs in those individuals who, prior to the anesthesia, have existing hypertension of the spinal fluid. The abducens nerve, already partially deprived of its reserve by the pressure to which it has been subjected, loses its ability to withstand further increase in spinal pressure following the anesthetic. He maintains that therapeutic lumbar taps definitely ameliorate the subjective complaints and clinical findings. Some individuals still believe that it is the constant leakage of spinal fluid, with resulting hypotension, that will explain the picture. Others think that the drop in blood pressure produces an anemia of the bulbar centers, with the abducens nerve being the most susceptible. The above, however, will not explain the preponderance of unilateral lesions.

In considering the toxic factor we refer essentially to the drugs used as anesthetic agents. Blatt's review listed the following drugs as being the agents responsible in a series of 97 cases of ocular palsies: Stovaine 64 per cent, novocain 26 per cent, tropococaine 7 per cent, cocaine 3 per cent. In our cases nupercaine (1:1,500) and pontocaine (1 per cent) were the drugs employed.

Since the exact site of the pathologic process is still theoretical, the toxic action may be subdivided in the following manner: (1) Local; (2) reflex; and (3) general. By local toxic action is meant that the agent acts directly upon the nuclei or the nerves. Spielmeyer[9] observed certain changes at postmortem and reproduced, experimentally, in the dog and monkey the following findings: (1) Widespread lesions of the large anterior horn cells; and (2) evidence of degeneration throughout the entire length of the posterior columns as well as the posterior roots. He believed that there is a direct toxic action on the axon cylinders with subsequent secondary retrograde

degeneration of the ganglion cells. Perhaps this would explain the delayed appearance of abducens nerve paralysis. Lundy and his co-workers[10] studied the changes in the spinal cord of dogs produced by a dose of procaine sufficient to cause permanent and fatal paralysis. They found peripheral degeneration of the myelin in the anterior, lateral and posterior columns of the spinal cord. This work differed from that of Spiermeyer's in that no lesions were found in the nerve roots or nerve cells.

The theory of reflex toxic action is based upon an occasional associated labyrinthine disturbance. It is thought that this manifestation could be due to a toxic absorption with subsequent reflex abducens nerve involvement.

Because of the selective action of certain agents on nerves such as (a) diphtheria toxin for the soft palate, (b) lead for the radial nerve, (c) atoxyl for the optic nerve, and (d) ergot for the posterior cord, it is believed by analogy that possibly the toxic anesthetic agent is absorbed into the general circulation and then makes its way to the specific site of action. If this is true, however, the lesions should be bilateral, and certainly should occur following subcutaneous and intramuscular injections of these agents.

The inflammatory theory infers a low-grade meningitis produced by organisms of low toxicity. Its strongest supporters give great value to cases of ocular paralyses following the introduction of air into the cerebral ventricles for encephalographic purposes.

Preexisting diseases have been condemned as definite etiologic factors. In passing we mention lues, meningitis, hypophyseal tumors, hyperthyroidism and neuropathologic states as having been accused as predisposing at some time or other.

Paralysis of the abducens nerve is usually preceded by a period of headache, dizziness, nausea, stiff neck and photophobia, following which diplopia appears. The paralysis occurs from three to 21 days after the administration of the spinal anesthetic, as shown by the following data: 3–6 days, 45 per cent, 7–10 days, 30 per cent, 11–15 days, 15 per cent, 16–21 days, 10 per cent. The diagnosis is easily made because of the restriction of outward ocular movement and uncrossed diplopia. It was at one time thought that the left nerve was more frequently involved than the right but statistics fail to substantiate this point. Women are definitely more prone to develop this complication than men. The ratio of unilateral to bilateral lesions is 3:1. The duration of the above paralysis is shown as follows: 4 weeks, 54 per cent, 5–8 weeks, 26 per cent, 9–12 weeks, 10 per cent, 3–12 months, 10 per cent. The prognosis is usually favorable, with gradual subsidence of subjective complaints and clinical findings. Blatt, however, is less optimistic and maintains that, although one may expect a *"restitutio ad integrum,"* occasionally this complication may reactivate an existing neuropathologic condition which may prove fatal.

There is no specific therapy for paralysis of the abducens nerve following spinal anesthesia. The treatment is entirely palliative and usually aids in making the patient more comfortable. A spinal tap should be performed

and if the fluid is under increased pressure (manometric readings) then a sufficient amount should be removed in order to obtain a normal reading—5–15 cm. of water. The paralyzed eye should be covered in order to remove the distressing diplopia. This, however, should be limited to the shortest possible time because of the fact that exclusion of the fusion tendency prevents a compensatory innervation, and aids in the development of secondary contracture. Galvanic treatment, although much employed, is helpful only as a psychotherapeutic measure. Because of the danger of injuring the retina, the current must be so weak that it does not produce a contraction even of the normal muscles of the eye. Resection and recession of the muscles should not be resorted to for a period of two years if the muscle has failed to reestablish itself.

The following is a résumé of the two cases of paralysis of the abducens nerve occurring in our hospital following spinal anesthesia.

Case 1.—V. R., white, male, age 48, was admitted to the hospital, August 28, 1939, with the chief complaint of protruding hemorrhoids. Physical examination showed, in addition to the thrombosed hemorrhoidal veins, bilateral polycystic kidneys. A Mosenthal test revealed a fixed specific gravity at approximately 1.010.

Operation.—September 7, 1939: Eight cc. of nupercaine (1:1,500) was injected into the subarachnoid space between the second and third lumbar spaces. After waiting 30 minutes it was observed that no anesthesia was obtained, and the hemorrhoidectomy was performed after injecting novocain locally. The operative course was uneventful; the duration was 35 minutes.

Postoperative Course:

First and second days: No complaints.

Third and fourth days: Patient complained of severe frontal headaches.

Fifth day: In addition to the headaches the patient first complained of double vision which was exaggerated on looking to the right side. At this time, a spinal puncture was done, and the fluid was obtained under pressure of 6 cm. of water. It showed five cells per cubic millimeter. The Pandy test for globulin was negative. Examination of the fundi showed normal findings; pupils reacted to light and accommodation; no nystagmus. Paralysis of the right external rectus muscle was very obvious.

By the ninth postoperative day, the headaches had gradually subsided but it was not until the twenty-third day that the patient was free from diplopia, and at that time, occasionally, while looking off into the distance he experienced blurred vision. When the patient was discharged, on the twenty-fourth postoperative day, paralysis of the abducens nerve had entirely disappeared. A three-month follow-up revealed the patient free of symptoms.

Case 2.—W. B., white, male, age 17, was admitted to the hospital, September 5, 1939, with an undescended right testicle. Temperature 98.6° F., pulse 90, respirations 20, blood pressure 130/90. Physical examination was entirely negative other than that the right testicle was found in the inguinal canal.

Operation.—September 11, 1939: A first-stage Torek was performed under spinal anesthesia. Pontocaine (1 per cent solution), 1.2 cc. plus 1.2 cc. of spinal fluid, was injected between the third and fourth lumbar vertebrae. The anesthesia was entirely satisfactory, with the height obtained being equivalent to the level of the tenth dorsal nerves. The duration of operation was 60 minutes. The anesthetic course was uneventful.

Postoperative Course:

First and second days: Uneventful.

Third to fifth days: Intermittent headaches.

Sixth day: Patient complained of diplopia, particularly on looking to the right. Spinal puncture revealed the pressure to be apparently normal (no manometric reading). Cytologic examination revealed two cells per cubic millimeter. The Pandy test was negative. Physical examination showed normal fundi and visual fields. The left pupil was slightly larger than the right and both reacted well to light and accommodation. Paralysis of the right external rectus muscle was present.

The headaches disappeared by the seventh day; the diplopia persisted but gradually became less pronounced. At time of discharge (twenty-first day) the patient complained of diplopia only when looking far into the distance.

An interesting point in the first case is that no anesthesia was obtained and yet paralysis of the abducens nerve ensued. What may be deduced from this observation? It certainly points against the theory of a direct toxic action. With the absence of fever; with the presence of negative cytologic findings; and with the blood counts normal, the theory of low grade inflammation as a causative factor seems remote. It is our contention that paralysis of the abducens nerve following spinal anesthesia is due to a disturbance in dynamics of the spinal fluid. The mechanics of this reaction are still unknown.

SUMMARY AND CONCLUSION

The clinical aspect of paralysis of the abducens nerve complicating spinal anesthesia is discussed. Two cases are presented.

The etiology of the complication is still unknown; however, we believe that the problem will be solved on the basis of a disturbance in the dynamics of the spinal fluid during spinal anesthesia.

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THE DEFORMED CHIN AND LOWER JAW

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THE SOCIAL ASPECTS of plastic surgery are of wide implication, and have been reviewed by the author[1] elsewhere. Suffice it to say that a deformed chin and lower jaw are most detrimental to one's appearance, and frequently such stigmata cause an inferiority complex in the individuals so afflicted, and they refuse to lead a normal social life. These unfortunates and the public have erroneously heard that a receding chin denotes weakness of character. The layman believes, therefore, that the dimensions of the chin give the face a characteristic expression of weakness or strength.

Plastic repair of the deformed nose has become an important and gratifying procedure. Its progress has been responsible for the demand and necessity for the correction of other facial feature defects to make them harmonize with the nasal repair and thus to create profile harmony. In cases of a combined large nose and receding chin (Figs. 5 and 6), much can be accomplished by the removal of the nasal hump followed by the transplantation of the hump over the front of the mandible.

The object of this paper is to evaluate the methods in use at present for the correction of chin and lower jaw deformities, and to show what we may expect from the surgical correction thereof. We shall not consider operative procedures that have been discarded, but only those which, after long experience, have proved their value. It behooves the surgeon to develop one method and to perfect his technic rather than to use several methods with confusion and poor results. This presentation does not include conditions arising from burn cicatrices, loss of substance, and disease, as the reparative surgery of such would involve a separate lengthy dissertation. In any plastic procedure, we strive toward a double goal. It is axiomatic to have functional adequacy and esthetic perfection. In the topic under discussion these two are complementary, because we cannot have perfect facial contour unless the teeth and mandible are faultless in occlusion.[2] Any degree of protrusion or retrusion of the mandible will affect the facial contour. The function of the mandible depends upon its contact with the superior maxilla. In other words, the teeth of the maxilla and the mandible must properly occlude. In prognathism, the lower jaw is too far forward, and is usually accompanied by underdevelopment of the superior maxilla. In mandibular recession, or retrusion, the lower jaw is too far backward. Uneven development of the sides of the mandible produces lateral asymmetry and imperfect lateral occlusion. The individual so affected has a tremendous functional disability, so far as mastication is concerned.[3] The use of prosthesis and orthodontics are satisfactory in only the minor deformities. The orthodontist is only successful, at best, when he is able to begin treatment early in life. Since mandibular deformities are progessive during the period of development, they

should be treated as soon as the permanent teeth erupt. In most cases where the orthodontist has improved function, the residual chin recession usually persists and necessitates plastic repair.

Reconstruction Program.—There are three distinct periods or phases of jaw reconstruction. The preoperative period, the operation itself, and the postoperative treatment. In the first phase, it is necessary to rule out any existing infection or systemic disease. Also, during this phase, plaster casts are made of the upper and lower teeth, as this is an aid in computing the occlusion after section of the bone. Roentgenograms are made (1) to determine the condition of the teeth which are to hold the splints for postoperative fixation; (2) to show any infected area; and (3) to visualize the location of the mandibular foramen, injury to which must be avoided in order to preserve the blood and nerve supply of the teeth. As a matter of record and as an aid in preparing the case, photographs are taken depicting the face from all angles. In cases of retruded chin, a plaster cast of the face is made on to which modeling clay may be added to determine the amount the chin is to be brought forward. Thus, the size and shape of the transplant to be used is calibrated. The technic of the operation itself is explained subsequently, and the postoperative treatment will be described under the topic treating each deformity.

Local anesthesia (2 per cent) novocain with 15 drops of 1–1000 adrenalin solution to the ounce) is used almost exclusively. It is obtained by blocking the mandibular division of the trifacial nerve and by supplementary local infiltration of the area. In addition to the external infiltrations, anesthesia of the inferior alveolar nerve is obtained by intra-oral block. General anesthesia, when used, is given via the nose through an endotracheal tube. Preoperative sedation is accomplished with a substantial dose of a barbiturate (4 gr. of sodium pentobarbital) given one and one-half hours prior to the operation. If the patient is not sufficiently composed 30 minutes before the operation, a narcotic is given (morphine sulphate 1/6 gr. with hyoscine 1/150 gr. The use of narcotics is to be avoided as it frequently causes vomiting, and thus disruption of the postoperative fixation of the jaws.

Prognathism.—Prognathism (Figs. 1 and 2) is a deformity of the lower jaw characterized by an abnormal protrusion of the mandible.[4] In this condition, the lower incisors are 1 to 3 cm. in advance of the upper incisors, and the lower teeth do not occlude with the upper teeth. In addition to the unsightly appearance of the patient, the masticating powers are completely crippled. Phonation is impaired because the cheeks and lips are unable to properly function. This condition is most often accompanied by underdevelopment of the maxilla. This underdevelopment of the maxilla is due to the tongue finding excessive room in the lower dental arch and thus it does not exert adequate pressure upon the upper arch (maxilla) to promote its full development. It is interesting to report the observation that in cases of prognathism the tongue undergoes a compensatory hypertrophy which subsides to normal after surgical correction of the jaw. The author prefers

to increase the efficiency of the jaws by osteotomy through the ramus of the mandible to lengthen the jaw when retruded, and to shorten the jaw by a similar procedure when prognathic. Too much emphasis cannot be made upon the importance of avoiding injury to the inferior alveolar nerve and vessels.

FIG. 1.—Prognathic jaw. Before operation.

FIG. 2.—Prognathic jaw. After operation. (Nasal plastic operation performed two weeks previous to jaw operation.)

Etiology.—Mandibular deformities are attributed to the following factors: (1) Any condition which hinders the contour of the mandible during the growth period, such as ankylosis of the temporomandibular joint; (2) cleft lip and palate; (3) thumb sucking; (4) constitutional disorders, such as rickets, syphilis, *etc.;* (5) endocrine disturbances such as acromegaly and cretinism; and (6) traumatisms and infections, such as unreduced fractures of the lower jaw, osteomyelitis, and contracting scars.

Dental consultation is of paramount importance in the correction of the mandibular deformities. The dentist must prepare the mouth for the operation, construct casts, and aid in devising the splints for fixation of the jaw in its new position. Following surgical correction, the dentist frequently aids the occlusion by orthodontic procedures. A combination of surgical correction and orthodontic treatment usually produces the best end-results. There are several classifications of mandibular deviations and the character of the bony deformity varies greatly. The classification is of relatively little value as in practically all cases the treatment is the same.

Treatment.—The treatment consists of an amalgamation of orthodontic, surgical, and sometimes prosthetic measures. Orthodontic measures attempt to improve the occlusion and correct facial asymmetry by subjecting the teeth to pressure. This pressure is, in turn, transmitted to the bony structures in a fashion which will force the teeth into a normal occlusion. By this method

the orthodontist endeavors to reshape the jaw. This is usually attempted by means of wire splints and rubber bands. These methods serve their best purpose in young individuals before puberty. Soon after this time the bone is no longer pliable and only surgical treatment will produce the necessary physiologic and esthetic effect. Since a retruded or prognathic chin is of progressive severity during the developmental period of the jaws, the sooner it is treated the better. Many of these operative procedures can be obviated if the defective articulation is observed early and appropriate orthodontic measures started as soon as the permanent teeth erupt.

Surgical Treatment.—The choice of a method of surgical treatment is by (1) osteotomy or (2) ostectomy.

Osteotomy (Plate A) is employed by dividing the ramus of the mandible followed by shifting of the body of the bone backward to the desired position, after which immobilization is maintained until ossification of the bone is complete. This is the most satisfactory of the operative procedures because it is simple in conception, entails no sacrifice of the bone, no injury to its blood and nerve supply, does not damage the mandibular arch and its teeth, obviates opening into the oral cavity, and reduces to a minimum the muscle traction which tends to obstruct the reduction. There are some dangers to this method. They are injury to the parotid gland, facial nerve, and internal maxillary artery. However, with ordinary care, practice and skill, these dangers are negligible.

The optimum site for the bone incision employed in this method is through the ascending ramus of the mandible in the area between the mandibular notch and the mandibular foramen. This is the safe area (Plate A, 3 b) and is above the entrance of the inferior alveolar nerve and vessels into the mandibular canal. Before the operation is started, the safe area is visualized roentgenologically. After the section of the ascending ramus, there is a tendency on the part of the upper fragment to become displaced by the temporal and external pterygoid muscles. When this does occur it would lead one to believe there would result a permanent closed or open bite. However, this is not the case, as the callus formation in this area is of sufficient strength to result in excellent function even where there is slight contact of the fragment edges (Plate A, 5 b). By this method the nerve and blood supply to the teeth are uninterrupted and the resultant function is normal.

Other operators have described various locations at which to perform the osteotomy, such as section of the bone at the mandibular angles. At this site, the technic of the operation is simplified, but the blood and nerve supply is severed. Although good esthetic results have been reported, it is the author's experience that there is an unnecessary damage to the blood and nerve supply resulting in trophic disturbances of the teeth and loss of sensation anterior to the osteotomy. This and other methods are only mentioned to be condemned and, therefore, a description of these methods is purposely omitted. The technic used with great success is as follows:

Procedure (Plate A).—A stab wound is made at a predetermined site

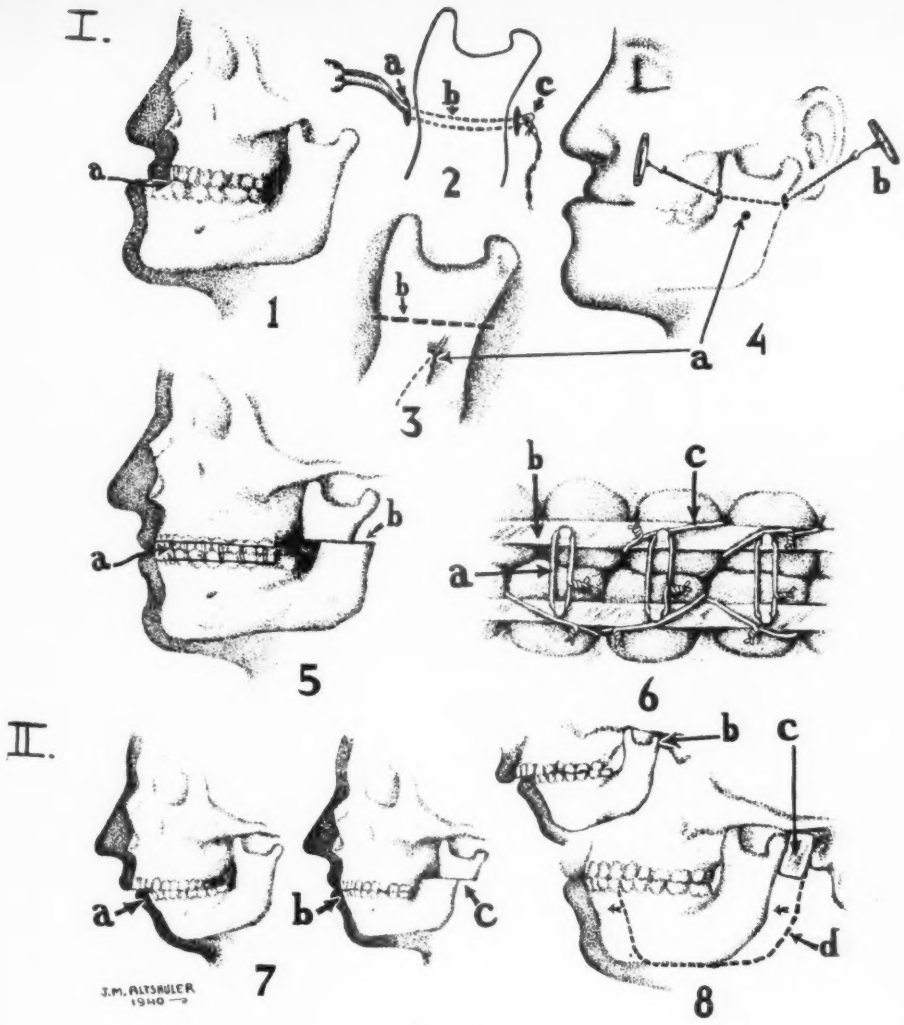

PLATE A

I. SURGICAL CORRECTION OF THE PROGNATHIC JAW

(1) Deformity.
  (a) Lack of occlusion between upper and lower incisor teeth.
(2) (a) Stab wound.
  (b) Pedicle needle passed behind ramus, hugging the bone closely so as to avoid penetration of oral mucous membrane.
  (c) Stab wound at point of emergence of pedicle needle and attachment of Gigli saw to pedicle needle.
(3) Internal view of ramus showing operative field:
  (a) Site of entrance of inferior alveolar nerve and vessels.
  (b) Site of proposed bone incision in "safe" area.
(4) (a) Site of entrance of inferior alveolar nerve and vessels.
  (b) Gigli saw in proper position for osteotomy.
(5) Deformity corrected:
  (a) Splints for immobilization of fragments after repositioning of bone.
  (b) Distance lower jaw is brought backward.
(6) Retention splints used for immobilization shown in detail:
  (a) Wires passed between lugs on arch-bars.
  (b) Arch-bars for upper and lower jaw.
  (c) Method of passing wires around arch-bars anchoring them to teeth.

II. SURGICAL CORRECTION OF THE RETRUDED LOWER JAW, WITHOUT NORMAL BITE

(7) (a) Degree of retrusion showing malocclusion of teeth.
  (b) Advancement of jaw correcting bite.
  (c) Distance lower jaw is advanced.
(8) Alternate method of surgical correction (Babcock).
  (b) Site for cartilage implant.
  (c) Quadrilateral section of rib cartilage inserted between condyle of mandible and bony acoustic meatus.
  (d) Resultant amount of lower jaw advancement.

approximately 2.5 cm. above and behind the angle of the mandible. A specially prepared curved pedicle needle is introduced, hugging the bone as close as possible on the inner surface of the ramus of the mandible. (This needle forms nearly a half circle, 4 cm. in diameter.) The point of the needle emerges by way of a stab wound at the anterior border of the ramus of the mandible. A heavy silk suture is passed through the eye of the needle and this pilots a Gigli saw into position (Plate A, 2). In this area the ascending ramus is sectioned horizontally between the mandibular foramen and the mandibular notch (Plate A, 3 and 4). The same technic is carried out on the opposite ramus. After this, it is possible to push back the body of the mandible until the desired occlusion of the teeth is reached (Plate A, 5). The upper and lower teeth are then fixed in proper occlusion with suitable splints and wire ligatures. There are many types of retention splints used but the one shown on the accompanying Plate has been found most satisfactory by the author (Plate A, 6). These splints are attached to the teeth the day preceding the operation and are wired together immediately following the operation. Single arch-bars containing lugs are attached, one to the upper and one to the lower teeth, by means of wires passed around the teeth. Wires are then passed between the lugs on the arch-bars, holding the jaws immobilized. The jaws are thus retained in position with these wires for ten weeks, after which time union of the fractures has taken place and normal function of the jaw is imminent. It is necessary to tighten the wires at weekly intervals so as to insure complete immobility during the healing period.

This apparatus, used for immobilizing the jaws, is kept on longer than necessary (usually ten weeks) so as to avoid refractures that would follow early removal and use of the jaw. Roentgenograms aid in visualizing the amount of ossification present. The best indication, however, is the decreasing amount of tenderness over the site of the bone incision. After the splints have been discarded, there is some limitation of motion because of the prolonged period of fixation. This stiffness disappears after a few days of progressive mastication. Physiotherapy and massage are aids.

Postoperative Treatment.—Antiseptic sprays, mouth washes, and frequent brushing of the teeth is advised. The diet consists primarily of liquids with some semisolids. It should contain sufficient caloric value to maintain the patient's normal weight and at the same time avoid constipation. The average adult, weighing 70 Kg., requires a diet of 2,500 to 3,000 calories daily. A variety of food and liquids, well cooked and properly flavored and seasoned to tempt the appetite, are prescribed. Meats prepared with a grinder are taken easily and a large amount of food is sucked between the teeth without any difficulty. Many adequate diets consisting of milk drinks, fruit puices, puréed vegetables, *etc.*, have been described.[5] If for any reason the food cannot be drawn in, it can easily be sucked through a rubber tube, passed behind the last molar tooth or through any empty socket, if present.

In the rare case where these methods are not applicable, a soft, well-greased catheter is passed into the pharynx.

Ostectomy is an open operation and consists of the removal of a section of bone from both sides of the horizontal ramus of the mandible and the repositioning of the bone backward into the space thus created so that the teeth will fall into normal occlusion.

An incision is made under the horizontal ramus, the periosteum is elevated and the bone is resected according to a previously prepared pattern. This can be done with a Gigli saw or a chisel. The bone fragments are immobilized by previously constructed splints and also by wiring the detached portions, which may ultimately necessitate an additional operative procedure for the removal of this wire.

This method, which is advocated by some surgeons, has additional disadvantages and the author advises against its use for the following reasons: (1) If the jaw is not edentulous at a convenient location, teeth have to be extracted in order to make room for the excision of bone. Thereafter, sufficient time must be allowed for healing. The extraction is usually done five to six weeks before the operation; (2) there is considerable scarring due to the external incisions when this method is used; and (3) the danger of infection is increased, due to oral contamination sometimes resulting in osteomyelitis.

Retrusion of the Lower Jaw with Normal Bite.—This group includes micrognenia which is entirely an esthetic defect. This condition is due either to underdevelopment of the front of the mandible (mentum) or a defect in the fatty cushion covering this area. The repair demands the addition of a transplant to bring the chin forward the required distance. Various types of implants have been used for this purpose, such as ivory, iliac bone, fat, and dermal grafts, and prosthesis. Only two materials which have proven satisfactory in the greatest majority of cases will be described. One is the osteocartilaginous nasal hump, which may be removed from the nose when it accompanies a slight chin recession (Figs. 5 and 6). It is easily obtained by endonasal rhinoplasty. After removing the periosteum and nasal mucosa, the hump is inserted in the chin as shown in Plate B. The author has also successfully transplanted such a nasal hump from one individual to the saddle nose of another, proving its adaptability in many locations as a graft. When there is no accompanying nasal hump available for the chin, refrigerated human cartilage is used (Figs. 3 and 4). This makes the ideal transplant material for all surface defects. This cartilage is easily acquired from autopsies of nonpathologic specimens, especially accident-death cases.

The cartilage is denuded of its perichondrium and refrigerated in a solution of aqueous merthiolate one part to four parts of sterile normal saline.[6] It may be stored indefinitely. The solution is changed every four weeks, and each time before use a culture of the solution is taken. The author is yet to obtain a positive growth from this solution. This cartilage can be transplanted regardless of age, sex, or color. Its use is restricted until it has been

FIG. 3.—Retrusion of lower jaw, with normal bite. Before operation.

FIG. 4.—After operation—Retrusion of lower jaw repaired with modeled, refrigerated, human cartilage graft. (Nasal plastic performed at same operation.)

FIG. 5.—Combined nose and chin deformity. Before operation.

FIG. 6.—After operation. (Retrusion of chin corrected with "hump" from nose obtained by endonasal rhinoplasty at same operation).

refrigerated at least one week. A few of its many advantages are: (1) It is easy to obtain; (2) it does not curl; (3) it can be made sterile; (4) it obviates the necessity of a chest operation for rib cartilage and the complications thereof, such as scars, opening into the pleura, *etc.*; and (5) it is readily retained and assimilated by the tissues. It will be difficult to find a substitute for refrigerated human cartilage that will "take" as an implant in so high a percentage of cases, require removal so infrequently, and leave so satisfactory and enduring an esthetic effect.

The operative technics shown in Plate B are as follows: The skin is prepared with tinctures of green soap and metaphen, and a submental incision is made in the natural skin fold. A pocket, slightly larger than the size of the implant, is prepared with a comma-shaped knife carried down to the periosteum which is scarified to aid adherence of the implant. One end of the previously prepared transplant is inserted with bone forceps as far laterally as possible. A small two pronged pointed retractor is then inserted into the opposite end of the incision, which readily stretches until the protruding end of the graft can be brought into the pocket. The incision is then closed with a single suture of horse hair, and is covered with a strip of 5 per cent xeroform ointment gauze, over which is placed one layer of dry gauze, with a firm elastoplast dressing. This is assurance against misplacement of the graft and the formation of hematomata, either of which may cause failure.

Postoperative treatment is simple, as the patient has no discomfort. The diet consists of fluids for 24 hours and thereafter, as an aid in the immobilization of the graft; a soft diet is prescribed to avoid chewing. On the fourth day, the first dressing is done and the single suture removed. Another snug dressing is applied for three days until, at the end of the week, all bandages are removed. The incision rapidly becomes invisible.

Retrusion of the Lower Jaw without Normal Bite.—To correct this condition it is necessary to elongate the mandible. The chin and lower incisor teeth are far behind the normal position (Plate A, 7 a), thus, this condition is the antithesis of prognathism. Many methods of correction have been utilized with varying degrees of success, such as the method illustrated in Plate A, 8 b, c and d, where a block rib of cartilage is inserted between the mandibular condyle and the bony acoustic meatus. This advances the lower jaw the distance corresponding to the thickness of the cartilage graft, thus overcoming the retrusion.[7] The correction, however, is best obtained by exactly the same operative procedure as described above for the correction of prognathism. The operative technic, fixation of the jaws, and postoperative care are the same as described for prognathism. The horizontal sections (osteotomy) are made through each ascending ramus of the mandible, and are shown on Plate A, 4, permitting the advancement of the lower jaw to a forward position, as seen in Plate A, 7 b and c. The jaws are immobilized by means of splints attached to the teeth by the same method above described for prognathism (Plate A, 6). If this advancement of the lower jaw is not

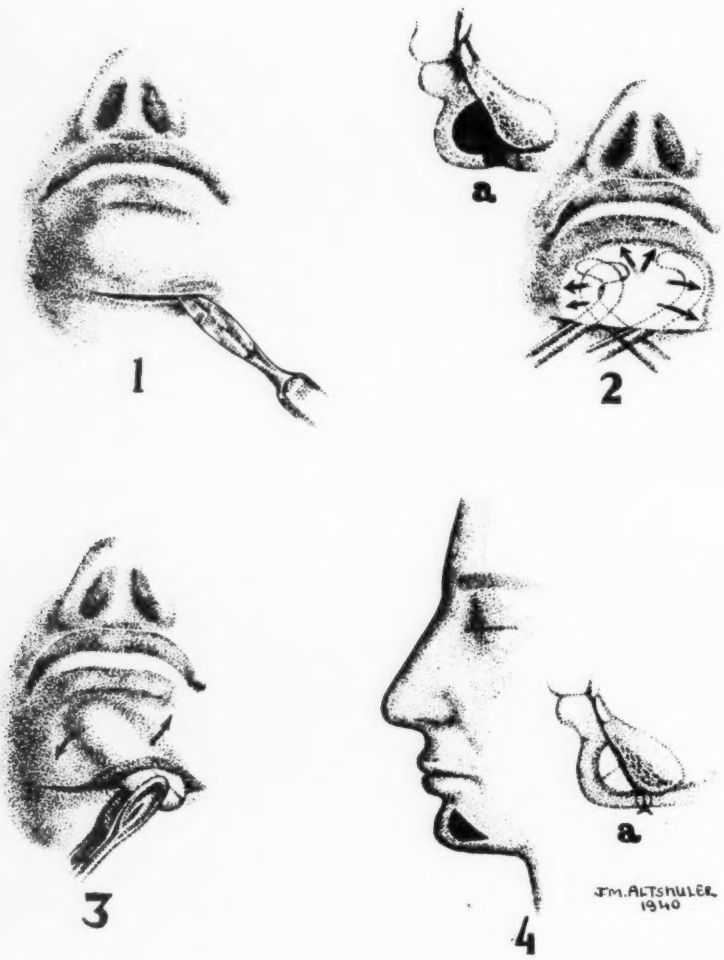

PLATE B

CORRECTION OF RECEDING CHIN

Unassociated with Malocclusion by Utilizing Modeled Refrigerated Human Cartilage Graft or Nasal "Hump"

(1) Submental incision in skin crease.
(2) Formation of pocket for implant:
  (a) Sagittal view of prepared bed for implant.
(3) Introduction of implant.
(4) Implant *in situ*:
  (a) Sagittal view showing implant *in situ*, with skin suture.

sufficient to overcome the retrusion, it may be supplemented by the addition of a refrigerated cartilage graft which will give further prominence to the chin, as shown in Plate B.

SUMMARY AND CONCLUSIONS

Deformities of the chin and lower jaw have a social and esthetic effect and, when accompanied by faulty occlusion of the teeth, there is a concurrent functional disability.

The correction by orthodontics is possible only when attempted early in life.

The three phases of jaw reconstruction are described.

The method of choice for the surgical correction of prognathism is osteotomy. The ramus of the mandible is sectioned at a predetermined site, in the "safe area" to avoid interruption of the blood and nerve supply, and the body of the mandible is pushed back into the desired position.

The postoperative fixation of the jaws is maintained by approximate interdental splints and wire ligatures.

Retrusion of the lower jaw, when accompanied by a normal bite, is best corrected by the addition of the osteocartilaginous hump obtained by endonasal rhinoplasty. When there is no accompanying nasal hump, refrigerated human cartilage is used.

Retrusion of the lower jaw without normal bite is corrected by the same method described for the correction of prognathism except that the lower jaw is moved forward to the desired position.

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BRIEF COMMUNICATION

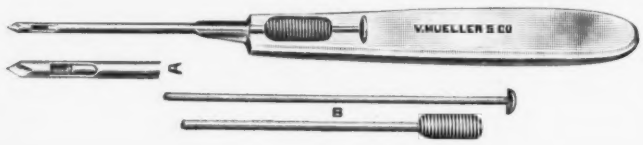
AN IMPROVED BIOPSY PUNCH

M. L. WEINSTEIN, M.D., M. SCHINDLER, M.D.,
AND E. LAWRENCE ADAMS, M.D.

CHICAGO, ILL.

FROM THE SURGICAL DEPARTMENT OF THE CHICAGO MEMORIAL HOSPITAL, CHICAGO, ILL.

THIS PUNCH* consists of three parts: A combined trocar and cannula (A), a No. 18-gauge cutting cylinder (B), and an obturator (Fig. 1). The mass for biopsy is perforated by the trocar and cannula, and within the latter the cutting cylinder is slid up and down, nipping off the desired tissue. The cylinder may then be removed and emptied of tissue by means of the obturator—leaving the combined trocar and cannula *in situ*. If the mass is cystic, fluid may escape through the cannula and its nature may be studied.



This instrument has proven useful for biopsy diagnosis in cases accessible for puncture, as in breast tumors, sarcomata of the extremities, lymph nodes, etc. It has been found particularly useful when the patient refuses incisional biopsy. The instrument has the added advantage of making a single puncture and taking as much tissue as may be required without reintroducing the trocar. In suspected malignancy, a coagulating current may be applied to the instrument or a fulgurating wire inserted through the cannula before the instrument is removed. In this way hemostasis and the spread of malignant cells may be controlled.

* The instrument is manufactured by V. Mueller Company, Chicago, Ill.

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